FCC Test Report

for

Senceive Ltd

Nano Macro Node

Model: FM3NT-50

FCC ID: 2AMFBFM3NTF
IC ID: 24373-FM3NTF

Project Engineer: R. Pennell

Approval Signatory

Approved signatories: D. Tiroke ☑ A. R. Coombes ☐

The above named are authorised Eurofins Hursley signatories.

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KC Lab ID: EU0184

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Document History:
Issue#1: 8th December 2020 was withdrawn and replaced by Issue#2: 17th Decemeber 2020 updated with editorial correction.

1.0 DECLARATION

1.1 FCC Class A Test Report

The Equipment Under Test (EUT), as described and reported within this document, complies with part 15.205, 15.209 and 15.247 of CFR 47 FCC rules in accordance with ANSI C63.4:2014 and ANSI C63.10:2013 measurement procedure referencing the following EMC tests:-

- RADIATED EMISSIONS - Airborne, from 30.0 MHz to 25 GHz

Note: The highest associated operating frequency on the system, as declared by the manufacturer is a clock rate of 2.475 GHz.

This report relates to the sample tested and may not represent the entire population. It is valid only for the product identified, either in part or in full, to the relevant electromagnetic requirements necessary for compliance.

Eurofins Hursley is recognized by the Federal Communications Commissions (FCC) as an EMI laboratory, outside of the USA, for the measurement of radiated emissions at three metres.

1.2 Product Modifications

None to sample submitted.

2.0 EQUIPMENT & TEST DETAILS

2.1 General

Product (EUT):	Nano Macro Node Model: FM3NT-50 Serial number: 000000
Product mains rating:	Battery
Product build level:	Production sample
Product manufacturer:	Senceive Ltd
Customer:	Senceive Ltd 7b/7c Imperial Studios Imperial Road Fulham London SW6 2AG United kingdom
Test commissioned by:	Mr Charlie Blackham (Sulis Consultants)
EMC Test lab reference:	Eurofins Hursley Files: 2434 Sulis Consultants Test Plan: 2434 RF Test
Date EUT received:	20th November 2020
Test date(s):	20th to 24th November 2020
EMC measurement site:	Eurofins Hursley Trafalgar House, Trafalgar Close, Chandlers Ford, Hampshire
IC Canada ID:	UK0005

2.2 EUT Description

The device operates inside the 2400 – 2483.5 MHz band with a single bandwidth and single modulation. The following test frequencies were used to cover the full band of operation of the device:

Test Channel	Centre Frequency (MHz)
Bottom channel	2405.0
Middle channel	2440.0
Top channel	2475.0

Table 1: Test frequencies

2.3 EUT Test Exerciser

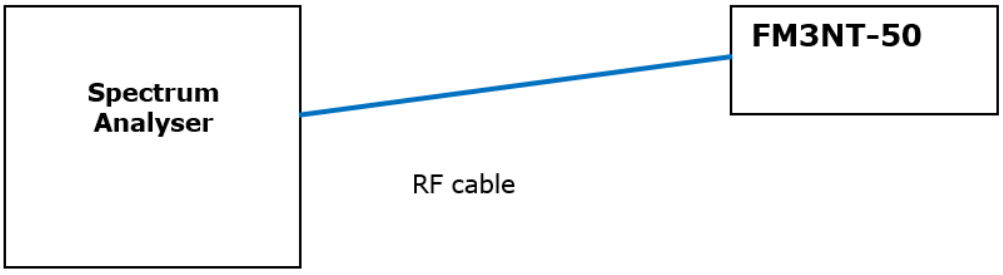
For the purposes of testing, the EUT was configured with test firmware that transmitted continuously with a 100% duty cycle.

The RF test cable is the internal cable to the Node that was connected directly to the Spectrum Analyser via a UF.L to N-Type adapter.

2.4 EUT Support Equipment

None.

2.5 EUT Test Configuration



2.6 Environmental Test Conditions

Temperature	17.4 to 20.9º Celsius
Relative Humidity	42 to 46%
Atmospheric Pressure	1017.1 to 1037.2 millibars

2.7 EMC Test Equipment

#ID	CP	Manufacturer	Type	Serial Nø	Description	Calibration due date
021	1	Rohde & Schwarz	ESIB	100192	Test receiver (40GHz)	12/08/2021
250	1	HP	8449B	3008A01077	Pre-amplifier (1.0-26.5GHz)	26/02/2021
357	1	Microtronics	BRN50702-01	25	Notch Filter	17/11/2021
456	1	Rohde & Schwarz	ESCI7	1144573407	EMI Test Receiver	26/08/2021
466	3	Schwarzbeck	BBHA 9120 571	571	1-10GHz Horn	28/02/2022
651	1	Rohde & Schwarz	ESIB 40 no.2	100262	40GHz receiver	25/11/2020
750	1	Global	CISPR16 chamber	1	11 x 7 x 6.2m	11/11/2021
761	3	Schwarzbeck	VULB9162	128	Trilog Broadband Antenna 30-7000MHz	02/03/2023
761a	3	Schwarzbeck	DGA 9552N	0	6dB attenuator for #761	02/03/2023
769	3	Schwarzbeck	BBHA 9120 C	631	2-18GHz Horn antenna (RE)	06/12/2020
779	3	Steatite	QWH-SL-18-40-K-SG	17504	18-40GHz wideband horn antenna	11/05/2021

CP = Interval period [year] prescribed for external calibrations
Note: 'Calibration due date' means that the instrument is certified with a UKAS or traceable calibration certificate.
'Internal' means internally calibrated using Eurofins Hursley procedures

2.8 EMC Test Software

The following table shows the current EMC test equipment software used by Eurofins Hursley:

ID	Manufacturer	Description
856	Rohde & Schwarz	EMC32 Version 10.50.10
857	Gauss	TDMI 30 Version 5.00
858	Ametek	Compliance 5 Immunity Version 5.26.48
859	EMC Partner	HARCS Version 4.22
860	Frankonia	Hurbert IEC1000-4-6 Version 1.3.0
861	Schaffner	Win 2110 Version 1.27.0.3
862	EMC Partner	TEMA3000 Version 4.4.2
863	EFH	ProfilaMil Version 2.8.1
864	AFJ	CL55C Version 1.00

2.10 Radiated Emissions

Initial Scan

Radiated profile scans were taken on eight azimuths between 30.0 MHz and 25.0 GHz in both the vertical and horizontal polarities of the antennae in a semi-anechoic chamber at 110V/60Hz. The resulting data obtained from these scans was used to determine subsequent measurement for final measurement evaluation.

Final Measurements

The EUT was then measured at three metres in the chamber using the pre-scan results as a guide. Emissions from the EUT were maximised by revolving the system on the turntable and moving the antennae in height and azimuth. Cable and system component positions had been investigated for maximum emissions, and the system under test represented the worst-case configuration. The highest values obtained are presented in this report.

3.0 EMISSION RESULTS

3.1 Radiated Emissions; 30 to 1000 MHz

Radiated emissions pre-scan profile measurements were taken at a distance of three metres on eight azimuths of the EUT in both horizontal and vertical antenna polarities in a semi-anechoic chamber for FCC measurements.

Using the pre-scan results as a guide, each emission from the EUT was maximised. Measurements were carried out a distance of three metres in a CISPR 16-1-4 compliant semi-anechoic chamber. Cable positions were then finally adjusted to produce the maximum emission levels. The EUT was tested in 3 axis and the worst-case results are shown below.

3.1.1 Data; Orientation 1, flat, Mid channel

Emission frequency	Measured quasi-peak value	Class B specified quasi-peak limit	Pass Margin	Antenna polarity	Antenna height	Turntable azimuth	
MHz	dBµV/m	dBµV/m	dB	H/V	cm	deg	Status
No significant peaks found.							Pass

V = Vertical / H = Horizontal

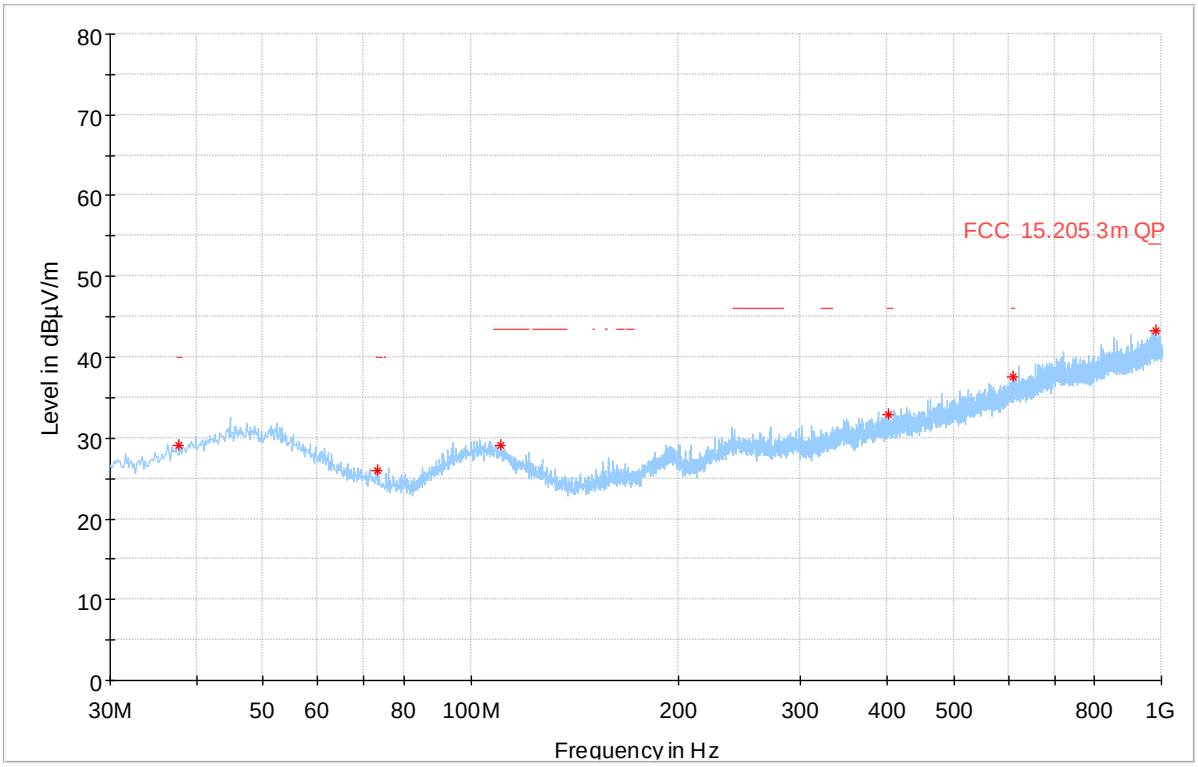
The measurements reported are the highest emissions relative to the FCC Class B limits and take into account the antenna and cable loss factors. Measurements made according to the FCC test standard and Eurofins Hursley test procedure RAD-01.

TEST ENGINEER: Malcolm Musgrave

3.1.2 Profile; Orientation 1, flat, Mid channel

Max hold trace with quasi-peak values (◆)

Peak measurements are shown in red (✳)



3.2 Radiated Emissions; 30 to 1000 MHz (continued)

3.2.1 Data; Orientation 2, serial cable at bottom, Mid channel

Emission frequency	Measured quasi-peak value	Class B specified quasi-peak limit	Pass Margin	Antenna polarity	Antenna height	Turntable azimuth	
MHz	dBµV/m	dBµV/m	dB	H/V	cm	deg	Status
No significant peaks found.							Pass

V = Vertical / H = Horizontal

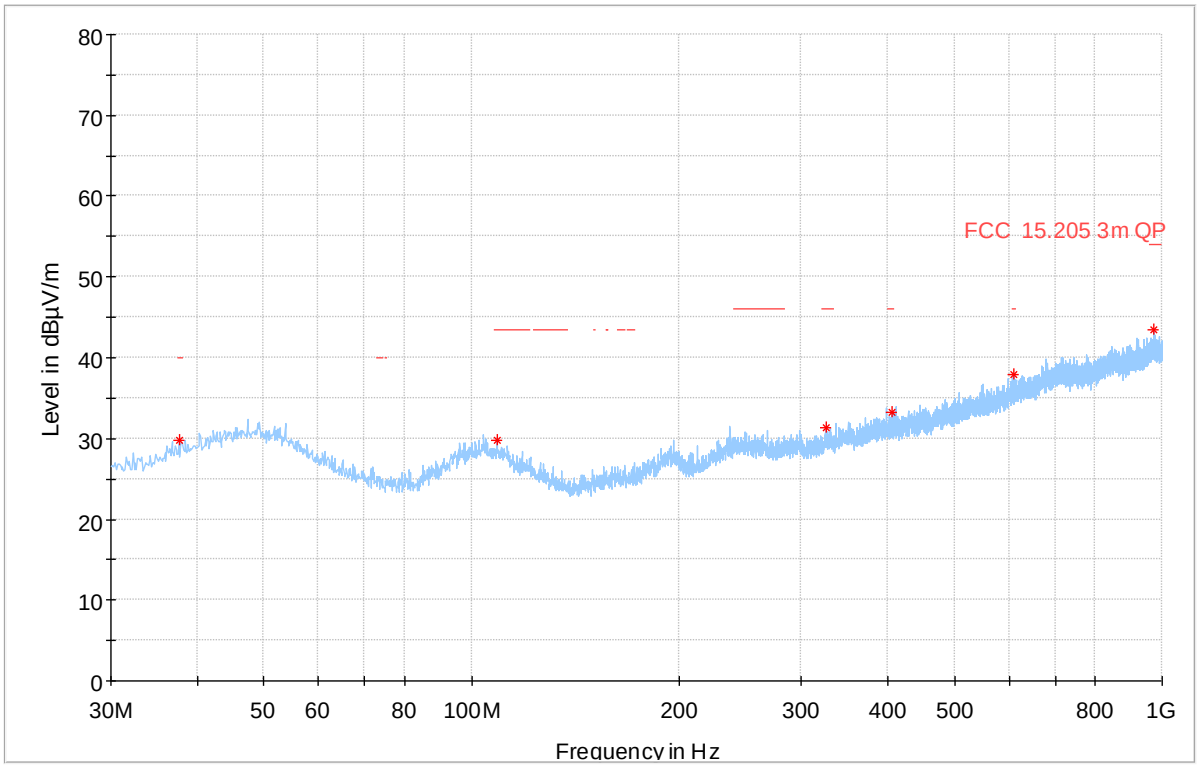
The measurements reported are the highest emissions relative to the FCC Class B limits and take into account the antenna and cable loss factors. Measurements made according to the FCC test standard and Eurofins Hursley test procedure RAD-01.

TEST ENGINEER: Malcolm Musgrave

3.2.2 Profile; Orientation 2, serial cable at bottom, Mid channel

Max hold trace with quasi-peak values (◆)

Peak measurements are shown in red (✳)



3.3 Radiated Emissions; 30 to 1000 MHz (continued)

3.3.1 Data; Orientation 3, serial cable at side, Mid channel

Emission frequency	Measured quasi-peak value	Class B specified quasi-peak limit	Pass Margin	Antenna polarity	Antenna height	Turntable azimuth	
MHz	dBµV/m	dBµV/m	dB	H/V	cm	deg	Status
37.638750	25.94	40.00	14.06	H	344.0	167.0	Pass
74.498750	21.84	40.00	18.16	V	192.0	334.0	Pass
111.116250	25.58	43.50	17.92	H	212.0	227.0	Pass
405.147500	29.68	46.00	16.32	V	277.0	188.0	Pass
608.483750	34.73	46.00	11.27	V	199.0	345.0	Pass
999.393750	40.01	54.00	13.99	V	231.0	51.0	Pass

V = Vertical / H = Horizontal

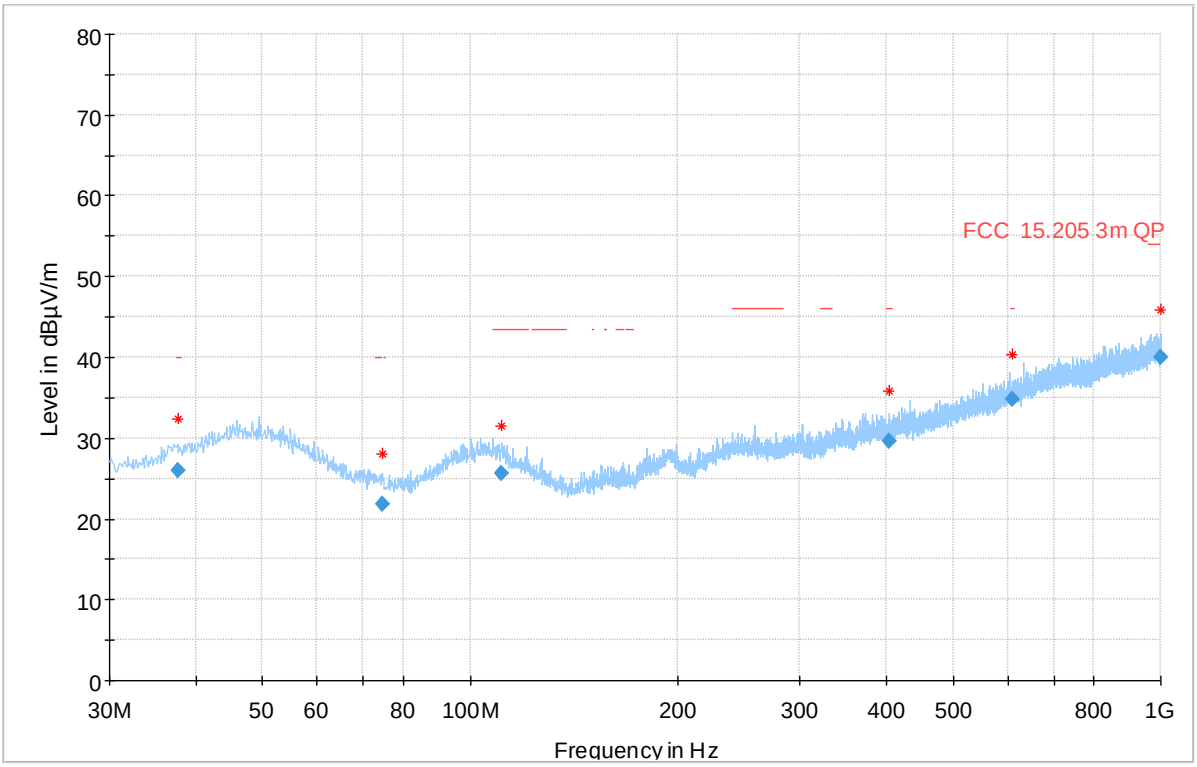
The measurements reported are the highest emissions relative to the FCC Class B limits and take into account the antenna and cable loss factors. Measurements made according to the FCC test standard and Eurofins Hursley test procedure RAD-01.

TEST ENGINEER: Malcolm Musgrave

3.3.2 Profile; Orientation 3, serial cable at side, Mid channel

Max hold trace with quasi-peak values (◆)

Peak measurements are shown in red (✳)



3.4 Radiated Emissions; 30 to 1000 MHz (continued)

3.4.1 Data; Orientation 3, serial cable at side, Bottom Channel

Emission frequency	Measured quasi-peak value	Class B specified quasi-peak limit	Pass Margin	Antenna polarity	Antenna height	Turntable azimuth	
MHz	dBµV/m	dBµV/m	dB	H/V	cm	deg	Status
No significant peaks found.							Pass

V = Vertical / H = Horizontal

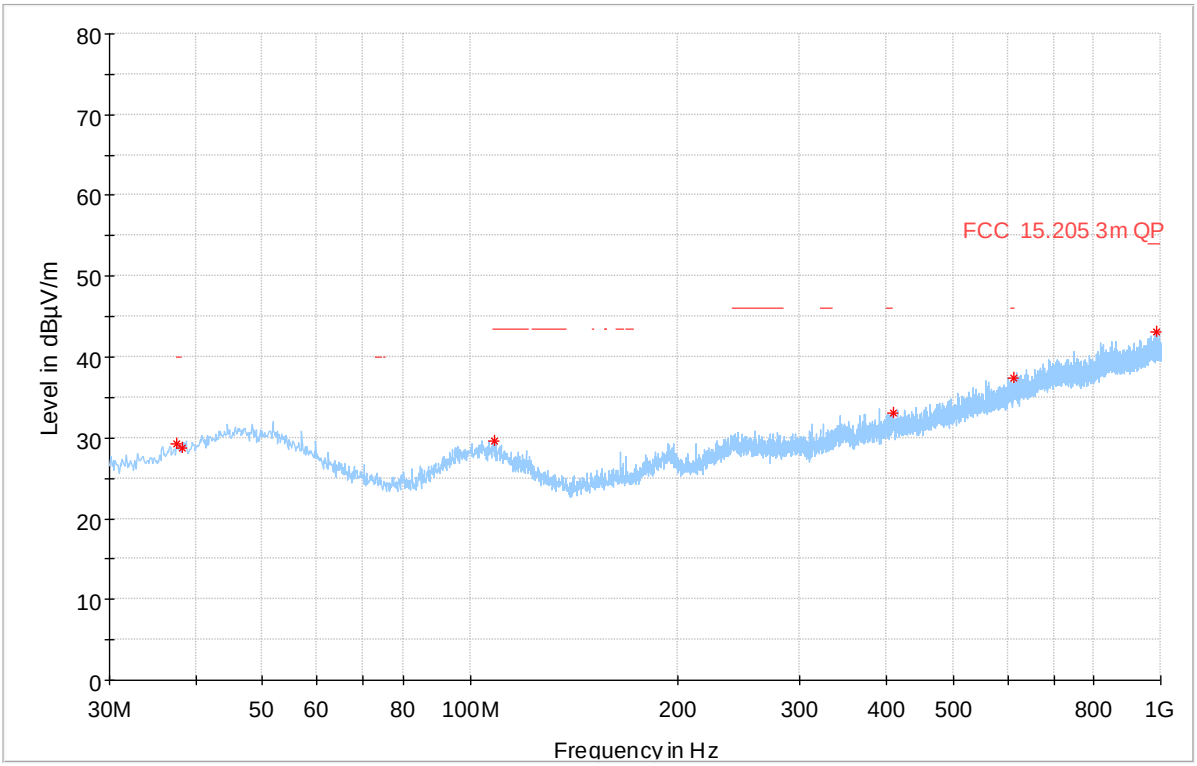
The measurements reported are the highest emissions relative to the FCC Class B limits and take into account the antenna and cable loss factors. Measurements made according to the FCC test standard and Eurofins Hursley test procedure RAD-01.

TEST ENGINEER: Malcolm Musgrave

3.4.2 Profile; Orientation 3, serial cable at side, Bottom Channel

Max hold trace with quasi-peak values (◆)

Peak measurements are shown in red (✳)



3.5 Radiated Emissions; 30 to 1000 MHz (continued)

3.5.1 Data; Orientation 3, serial cable at side, Top Channel

Emission frequency	Measured quasi-peak value	Class B specified quasi-peak limit	Pass Margin	Antenna polarity	Antenna height	Turntable azimuth	
MHz	dBµV/m	dBµV/m	dB	H/V	cm	deg	Status
No significant peaks found.							Pass

V = Vertical / H = Horizontal

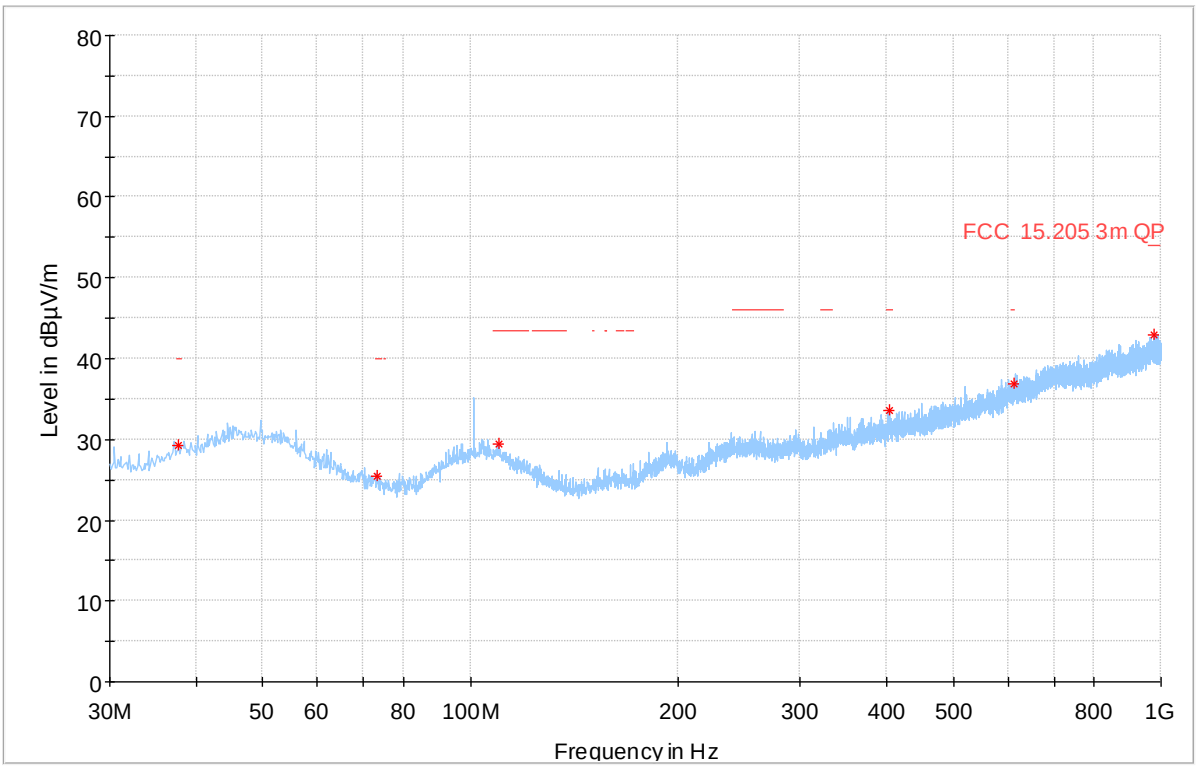
The measurements reported are the highest emissions relative to the FCC Class B limits and take into account the antenna and cable loss factors. Measurements made according to the FCC test standard and Eurofins Hursley test procedure RAD-01.

TEST ENGINEER: Malcolm Musgrave

3.5.2 Profile; Orientation 3, serial cable at side, Top Channel

Max hold trace with quasi-peak values (◆)

Peak measurements are shown in red (✳)



3.6 Radiated Emissions; 1 to 10 GHz

Radiated emissions pre-scan profile measurements were taken at a distance of three metres on eight azimuths of the EUT in both horizontal and vertical antenna polarities in a semi-anechoic chamber for FCC measurements.

Using the pre-scan results as a guide, each emission from the EUT was maximised. Measurements were carried out at a distance of three metres in a CISPR 16-1-4 compliant semi-anechoic chamber with a 2.45GHz notch filter fitted. Cable positions were then finally adjusted to produce the maximum emission levels. The EUT was tested in 3 axis and the worst-case results are recorded below.

3.6.1 Data; Orientation 1, flat, Mid channel (notch filter fitted)

Frequency	Peak	CISPR Average	Limit	Margin	Height	Pol	Azimuth	Corr.	
MHz	dBµV/m	dBµV/m	dBµV/	dB	cm	H/V	Deg	dB/m	Status
No significant peaks found.									Pass

V = Vertical / H = Horizontal

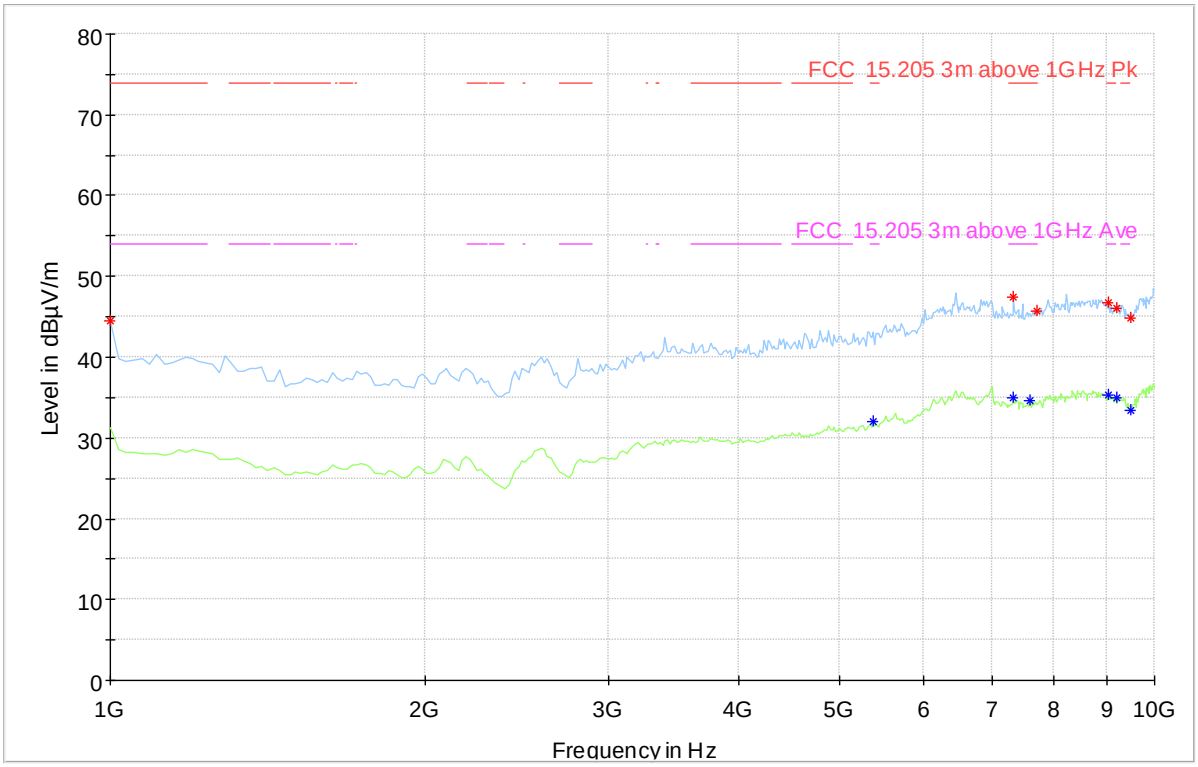
The measurements reported are the highest emissions relative to the FCC limits and take into account the antenna and cable loss factors. Measurements made according to the FCC test standard and Eurofins Hursley test procedure RHF-01.

TEST ENGINEER: Richard Pennell

3.6.2 Profile; Orientation 1, flat, Mid channel (notch filter fitted)

Max hold trace with peak values (◆)

Max hold trace with average values (◆)



3.7 Radiated Emissions; 1 to 10 GHz (continued)

3.7.1 Data; Orientation 2, serial cable at bottom, Mid channel (notch filter fitted)

Frequency	Peak	CISPR Average	Limit	Margin	Height	Pol	Azimuth	Corr.	
MHz	dBµV/m	dBµV/m	dBµV/	dB	cm	H/V	Deg	dB/m	Status
No significant peaks found.									Pass

V = Vertical / H = Horizontal

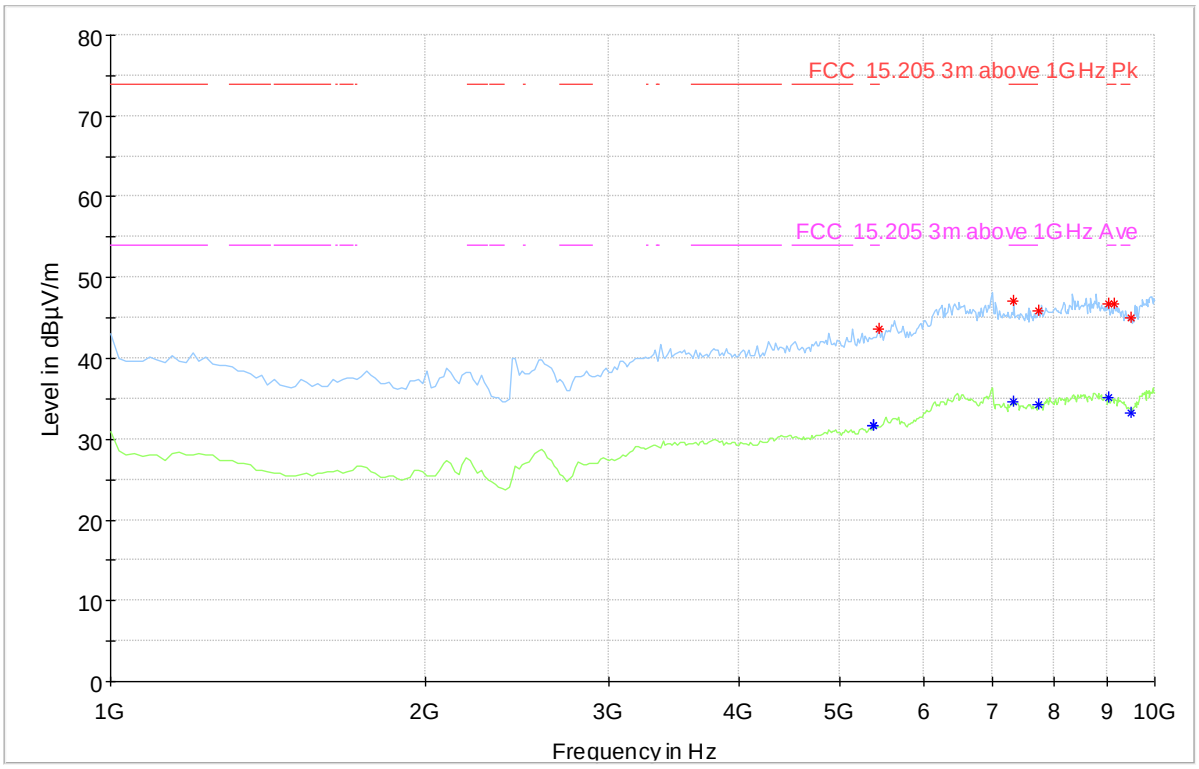
The measurements reported are the highest emissions relative to the FCC limits and take into account the antenna and cable loss factors. Measurements made according to the FCC test standard and Eurofins Hursley test procedure RHF-01.

TEST ENGINEER: Richard Pennell

3.7.2 Profile; Orientation 2, serial cable at bottom, Mid channel (notch filter fitted)

Max hold trace with peak values (◆)

Max hold trace with average values (◆)



3.8 Radiated Emissions; 1 to 10 GHz (continued)

3.8.1 Data; Orientation 3, serial cable at side, Mid channel (notch filter fitted)

Frequency	Peak	CISPR Average	Limit	Margin	Height	Pol	Azimuth	Corr.	
MHz	dBµV/m	dBµV/m	dBµV/	dB	cm	H/V	Deg	dB/m	Status
No significant peaks found.									Pass

V = Vertical / H = Horizontal

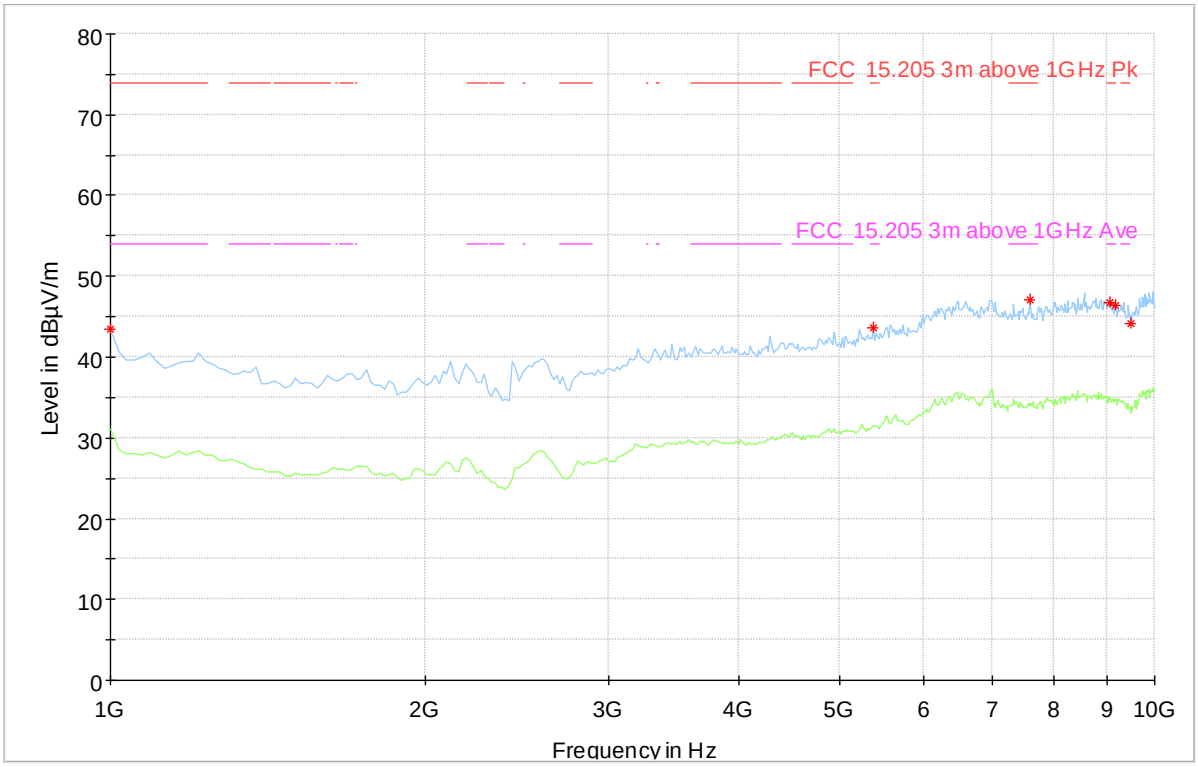
The measurements reported are the highest emissions relative to the FCC limits and take into account the antenna and cable loss factors. Measurements made according to the FCC test standard and Eurofins Hursley test procedure RHF-01.

TEST ENGINEER: Richard Pennell

3.8.2 Profile; Orientation 3, serial cable at side, Mid channel (notch filter fitted)

Max hold trace with peak values (◆)

Max hold trace with average values (◆)



3.9 Radiated Emissions; 1 to 10 GHz (continued)

3.9.1 Data; Orientation 3, serial cable at side, bottom channel (notch filter fitted)

Frequency	Peak	CISPR Average	Limit	Margin	Height	Pol	Azimuth	Corr.	
MHz	dBµV/m	dBµV/m	dBµV/	dB	cm	H/V	Deg	dB/m	Status
4810.00000	---	30.42	54.00	23.58	100.0	H	273.0	-2.0	Pass
4810.00000	45.36	---	74.00	28.64	172.0	H	278.0	-2.0	Pass

V = Vertical / H = Horizontal

The measurements reported are the highest emissions relative to the FCC limits and take into account the antenna and cable loss factors. Measurements made according to the FCC test standard and Eurofins Hursley test procedure RHF-01.

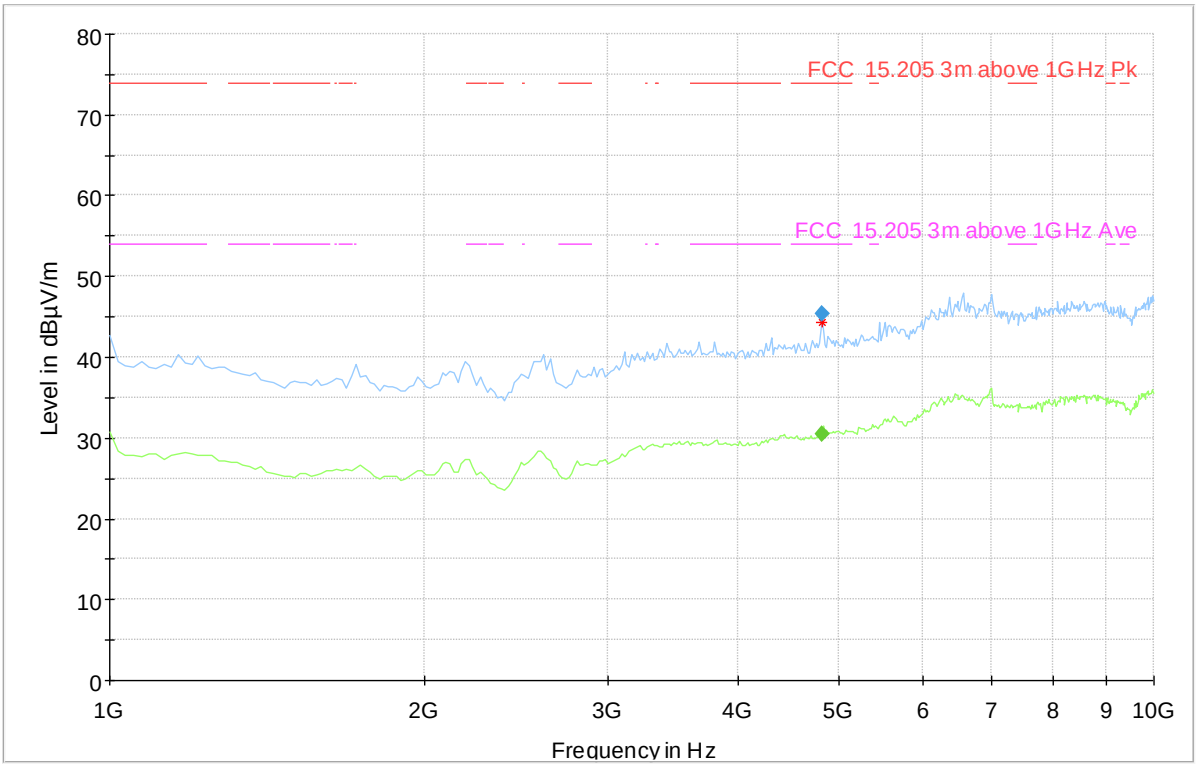
TEST ENGINEER: Richard Pennell

3.9.2 Profile; Orientation 3, serial cable at side, bottom channel (notch filter fitted)

Max hold trace with peak values (◆)

Peak measurements are shown in red (✳)

Max hold trace with average values (◆)



3.10 Radiated Emissions; 1 to 10 GHz (continued)

3.10.1 Data; Orientation 3, serial cable at side, top channel (notch filter fitted)

Frequency	Peak	CISPR Average	Limit	Margin	Height	Pol	Azimuth	Corr.	
MHz	dBµV/m	dBµV/m	dBµV/	dB	cm	H/V	Deg	dB/m	Status
No significant peaks found.									Pass

V = Vertical / H = Horizontal

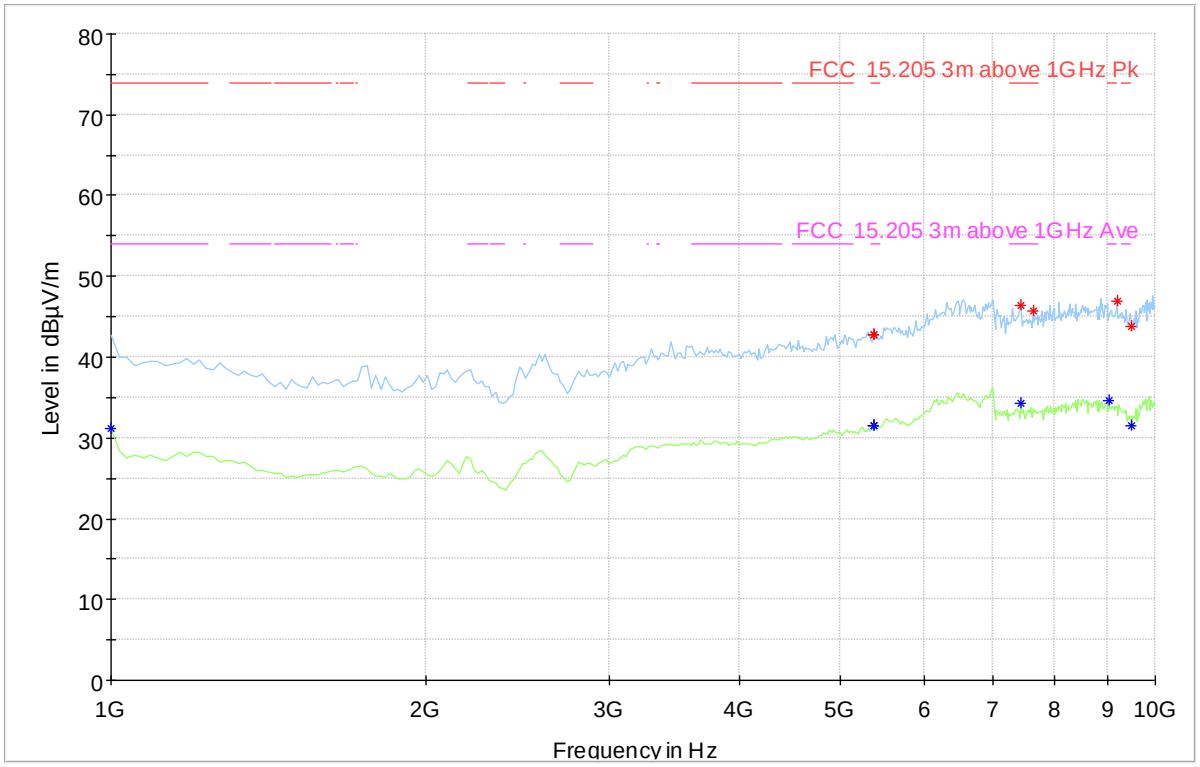
The measurements reported are the highest emissions relative to the FCC limits and take into account the antenna and cable loss factors. Measurements made according to the FCC test standard and Eurofins Hursley test procedure RHF-01.

TEST ENGINEER: Richard Pennell

3.10.2 Profile; Orientation 3, serial cable at side, top channel (notch filter fitted)

Max hold trace with peak values (◆)

Max hold trace with average values (◆)



3.11 Radiated Emissions; 2 to 3 GHz

Radiated emissions pre-scan profile measurements were taken at a distance of three metres on eight azimuths of the EUT in both horizontal and vertical antenna polarities in a semi-anechoic chamber for FCC measurements.

Using the pre-scan results as a guide, each emission from the EUT was maximised. Measurements were carried out a distance of three metres in a CISPR 16-1-4 compliant semi-anechoic chamber. Cable positions were then finally adjusted to produce the maximum emission levels. The EUT was tested in 3 axis and the worst-case results are recorded below.

3.11.1 Data; Orientation 1, flat, Top channel

Frequency	Peak	CISPR Average	Limit	Margin	Height	Pol	Azimuth	Corr.	
MHz	dBµV/	dBµV/m	dBµV/	dB	cm	H/V	Deg	dB/m	Status
2483.500000	---	44.05	54.00	9.95	125.0	V	318.0	-8.1	Pass
2483.500000	54.86	---	74.00	19.14	288.0	V	301.0	-8.1	Pass

V = Vertical / H = Horizontal

The measurements reported are the highest emissions relative to the FCC limits and take into account the antenna and cable loss factors. Measurements made according to the FCC test standard and Eurofins Hursley test procedure RHF-01.

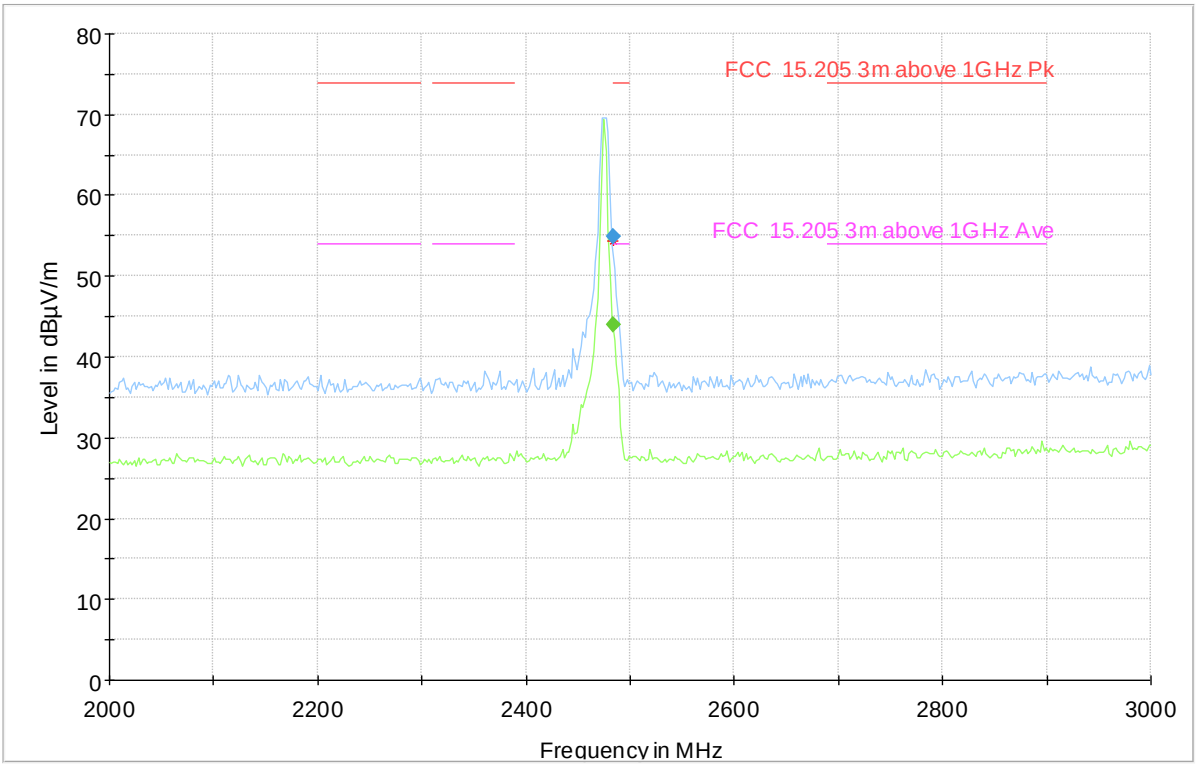
TEST ENGINEER: Richard Pennell

3.11.2 Profile; Orientation 1, flat, Top channel

Max hold trace with peak values (◆)

Peak measurements are shown in red (✳)

Max hold trace with average values (◆)



3.12 Radiated Emissions; 2 to 3 GHz (continued)

3.12.1 Data; Orientation 2, cable lower, Top channel

Frequency	Peak	CISPR Average	Limit	Margin	Height	Pol	Azimuth	Corr.	
MHz	dBµV/	dBµV/m	dBµV/	dB	cm	H/V	Deg	dB/m	Status
2483.500000	---	35.54	54.00	18.46	105.0	V	285.0	-8.1	Pass
2483.500000	47.33	---	74.00	26.67	141.0	V	286.0	-8.1	Pass

V = Vertical / H = Horizontal

The measurements reported are the highest emissions relative to the FCC limits and take into account the antenna and cable loss factors. Measurements made according to the FCC test standard and Eurofins Hursley test procedure RHF-01.

3.12.2 Data; Orientation 3, cable to side, Top channel

Frequency	Peak	CISPR Average	Limit	Margin	Height	Pol	Azimuth	Corr.	
MHz	dBµV/	dBµV/m	dBµV/	dB	cm	H/V	Deg	dB/m	Status
2483.500000	---	43.29	54.00	10.71	125.0	H	244.0	-8.1	Pass
2483.500000	53.16	---	74.00	20.84	128.0	H	236.0	-8.1	Pass

V = Vertical / H = Horizontal

The measurements reported are the highest emissions relative to the FCC limits and take into account the antenna and cable loss factors. Measurements made according to the FCC test standard and Eurofins Hursley test procedure RHF-01.

TEST ENGINEER: Richard Pennell

3.13 Radiated Emissions; 2 to 3 GHz (continued)

3.13.1 Data; Orientation 1, flat, Top channel

Frequency	Peak	CISPR Average	Limit	Margin	Height	Pol	Azimuth	Corr.	
MHz	dBµV/	dBµV/m	dBµV/	dB	cm	H/V	Deg	dB/m	Status
2483.5		44.22	54	9.78	108	V	278	-8.1	Pass
2483.5	54.58		74	19.42	115	V	283	-8.1	Pass

V = Vertical / H = Horizontal

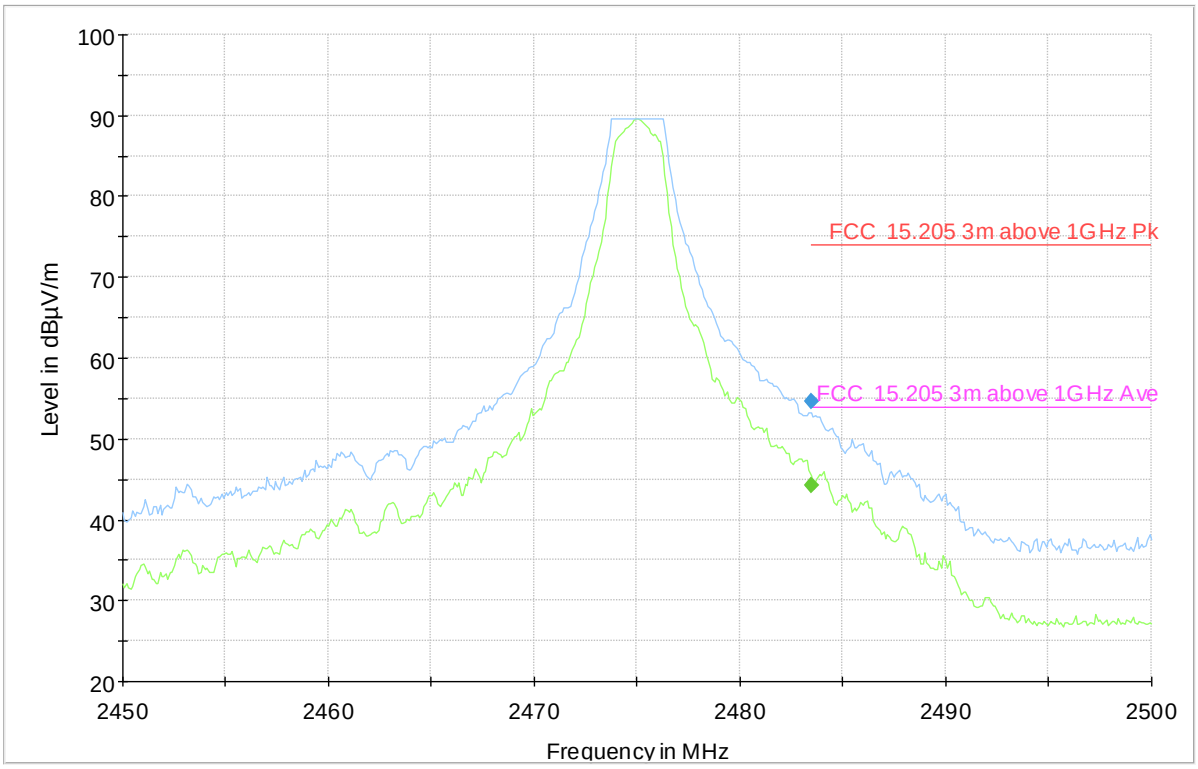
The measurements reported are the highest emissions relative to the FCC limits and take into account the antenna and cable loss factors. Measurements made according to the FCC test standard and Eurofins Hursley test procedure RHF-01.

3.13.2 Profile; Orientation 1, flat, Top channel

Max hold trace with peak values (◆)

Peak measurements are shown in red (✳)

Max hold trace with average values (◆)



3.14 Radiated Emissions; 2 to 3 GHz (continued)

3.14.1 Data; Orientation 1, flat, Bottom channel

Frequency	Peak	CISPR Average	Limit	Margin	Height	Pol	Azimuth	Corr.	
MHz	dBµV/	dBµV/m	dBµV/	dB	cm	H/V	Deg	dB/m	Status
No significant peaks found.									Pass

V = Vertical / H = Horizontal

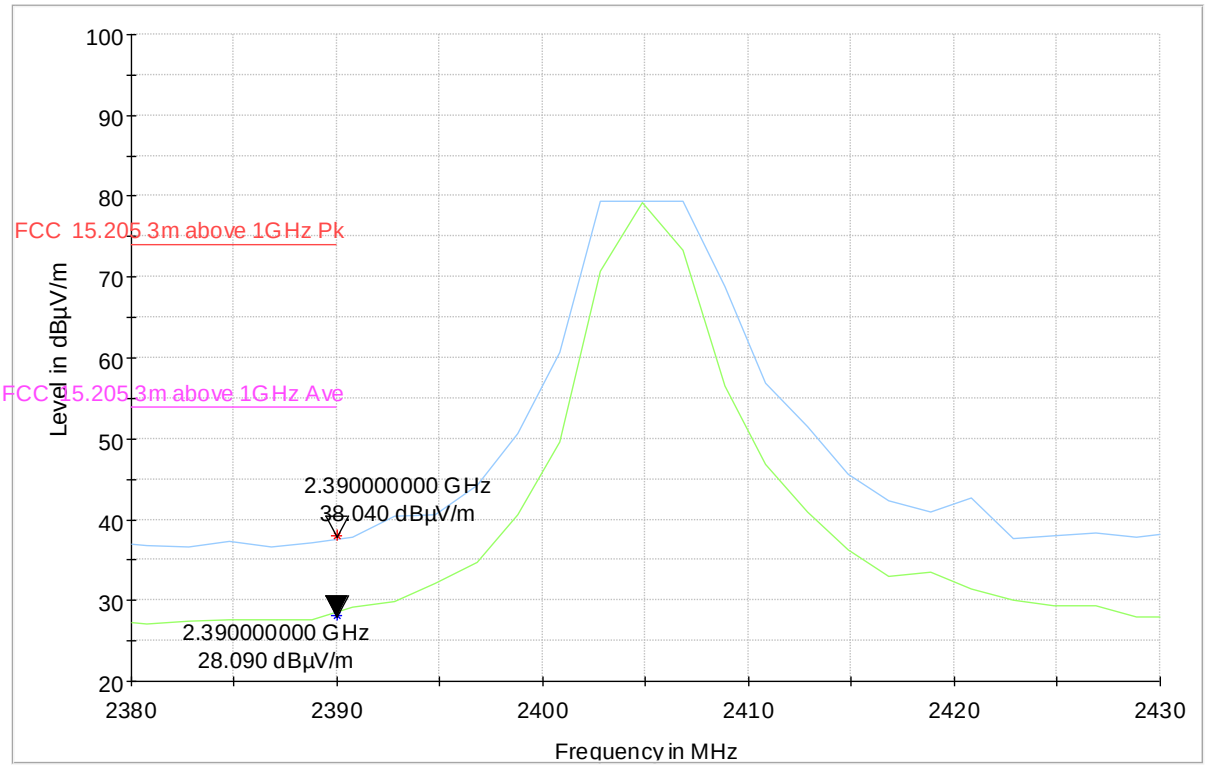
The measurements reported are the highest emissions relative to the FCC limits and take into account the antenna and cable loss factors. Measurements made according to the FCC test standard and Eurofins Hursley test procedure RHF-01.

3.14.2 Profile; Orientation 1, flat, Bottom channel

Max hold trace with peak values (◆)

Peak measurements are shown in red (✳)

Max hold trace with average values (◆)



3.15 Radiated Emissions; 2 to 3 GHz (continued)

3.15.1 Data; Orientation 2, serial cable at bottom, Bottom channel

Frequency	Peak	CISPR Average	Limit	Margin	Height	Pol	Azimuth	Corr.	
MHz	dBµV/	dBµV/m	dBµV/	dB	cm	H/V	Deg	dB/m	Status
No significant peaks found.									Pass

V = Vertical / H = Horizontal

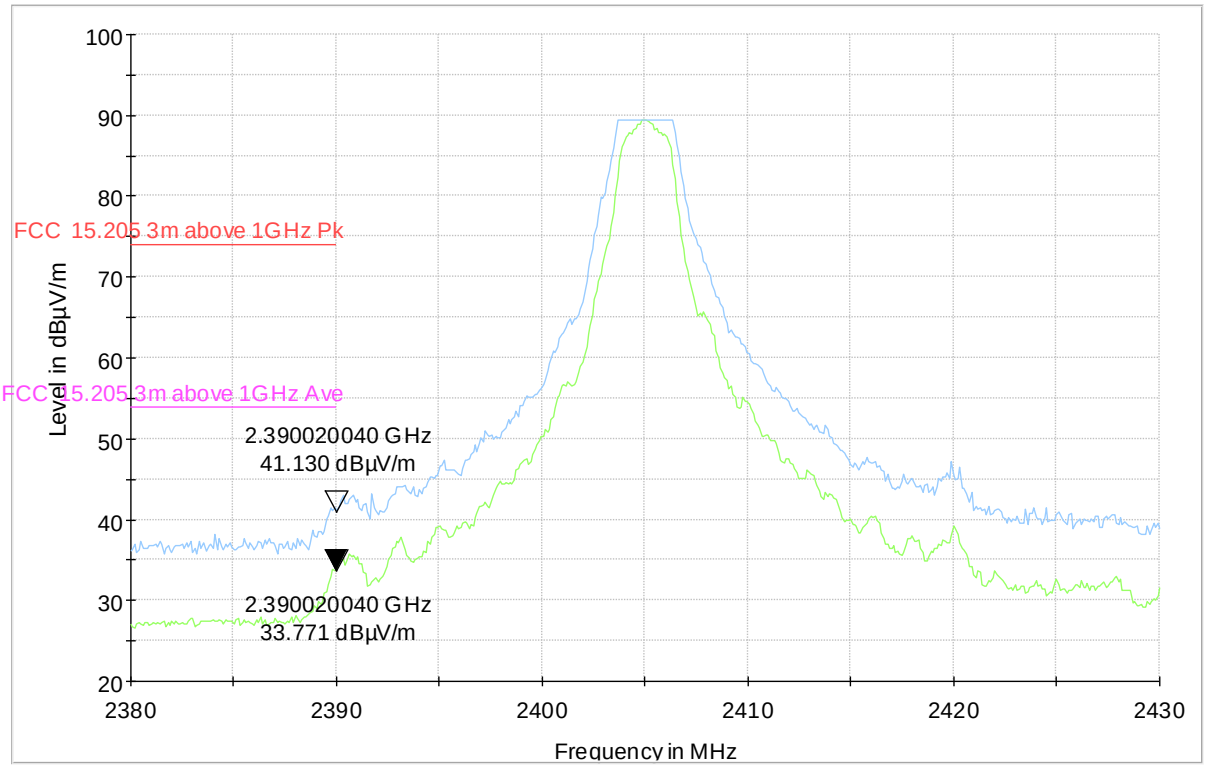
The measurements reported are the highest emissions relative to the FCC limits and take into account the antenna and cable loss factors. Measurements made according to the FCC test standard and Eurofins Hursley test procedure RHF-01.

3.15.2 Profile; Orientation 2, serial cable at bottom, Bottom channel

Max hold trace with peak values (◆)

Peak measurements are shown in red (✳)

Max hold trace with average values (◆)



3.16 Radiated Emissions; 2 to 3 GHz (continued)

3.16.1 Data; Orientation 3, serial cable at side, Bottom channel

Frequency	Peak	CISPR Average	Limit	Margin	Height	Pol	Azimuth	Corr.	
MHz	dBµV/	dBµV/m	dBµV/	dB	cm	H/V	Deg	dB/m	Status
No significant peaks found.									Pass

V = Vertical / H = Horizontal

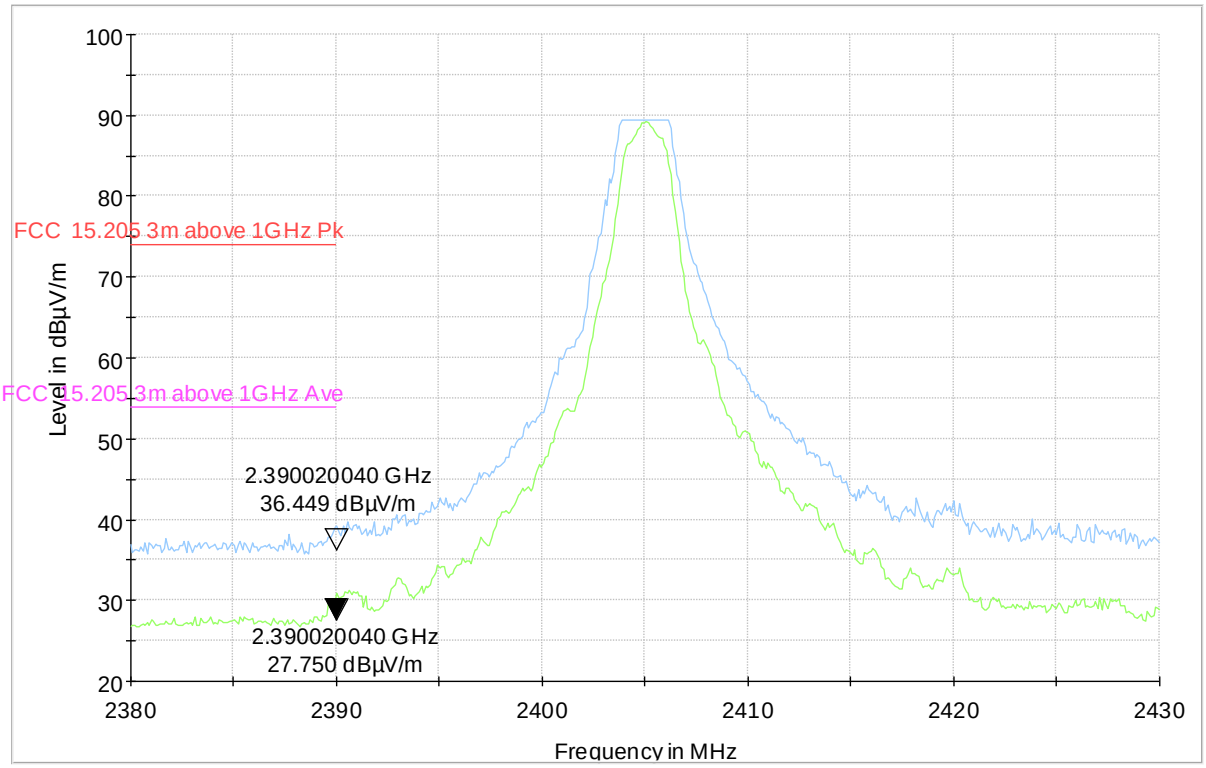
The measurements reported are the highest emissions relative to the FCC limits and take into account the antenna and cable loss factors. Measurements made according to the FCC test standard and Eurofins Hursley test procedure RHF-01.

3.16.2 Profile; Orientation 3, serial cable at side, Bottom channel

Max hold trace with peak values (◆)

Peak measurements are shown in red (✳)

Max hold trace with average values (◆)



3.17 Radiated Emissions; 10 to 18 GHz

Radiated emissions pre-scan profile measurements were taken at a distance of three metres on eight azimuths of the EUT in both horizontal and vertical antenna polarities in a semi-anechoic chamber for FCC measurements.

Using the pre-scan results as a guide, each emission from the EUT was maximised. Measurements were carried out a distance of three metres in a CISPR 16-1-4 compliant semi-anechoic chamber. Cable positions were then finally adjusted to produce the maximum emission levels. The EUT was tested in 3 axis and the worst-case results are recorded below.

3.17.1 Data; Orientation 1, flat, mid channel

Frequency	Peak	CISPR Average	Limit	Margin	Height	Pol	Azimuth	Corr.	
MHz	dBµV/	dBµV/m	dBµV/	dB	cm	H/V	Deg	dB/m	Status
12180.360722	56.88	---	74.00	17.12	199.0	V	80.0	10.9	Pass
13286.573146	---	44.35	54.00	9.65	323.0	H	314.0	12.8	Pass
13366.733467	57.15	---	74.00	16.85	216.0	V	203.0	12.9	Pass
14488.977956	---	45.58	54.00	8.42	165.0	H	272.0	13.7	Pass
14488.977956	59.97	---	74.00	14.04	112.0	V	228.0	13.7	Pass
15547.094188	59.45	---	74.00	14.55	354.0	V	82.0	13.2	Pass
15803.607215	---	46.10	54.00	7.90	135.0	V	207.0	13.3	Pass
16140.280561	60.04	---	74.00	13.96	339.0	H	210.0	13.7	Pass
16140.280561	---	46.20	54.00	7.80	400.0	V	0.0	13.7	Pass
16172.344689	---	46.28	54.00	7.72	202.0	V	68.0	13.7	Pass
17807.615231	---	48.02	54.00	5.98	205.0	V	124.0	16.1	Pass

V = Vertical / H = Horizontal

The measurements reported are the highest emissions relative to the FCC limits and take into account the antenna and cable loss factors. Measurements made according to the FCC test standard and Eurofins Hursley test procedure RHF-01.

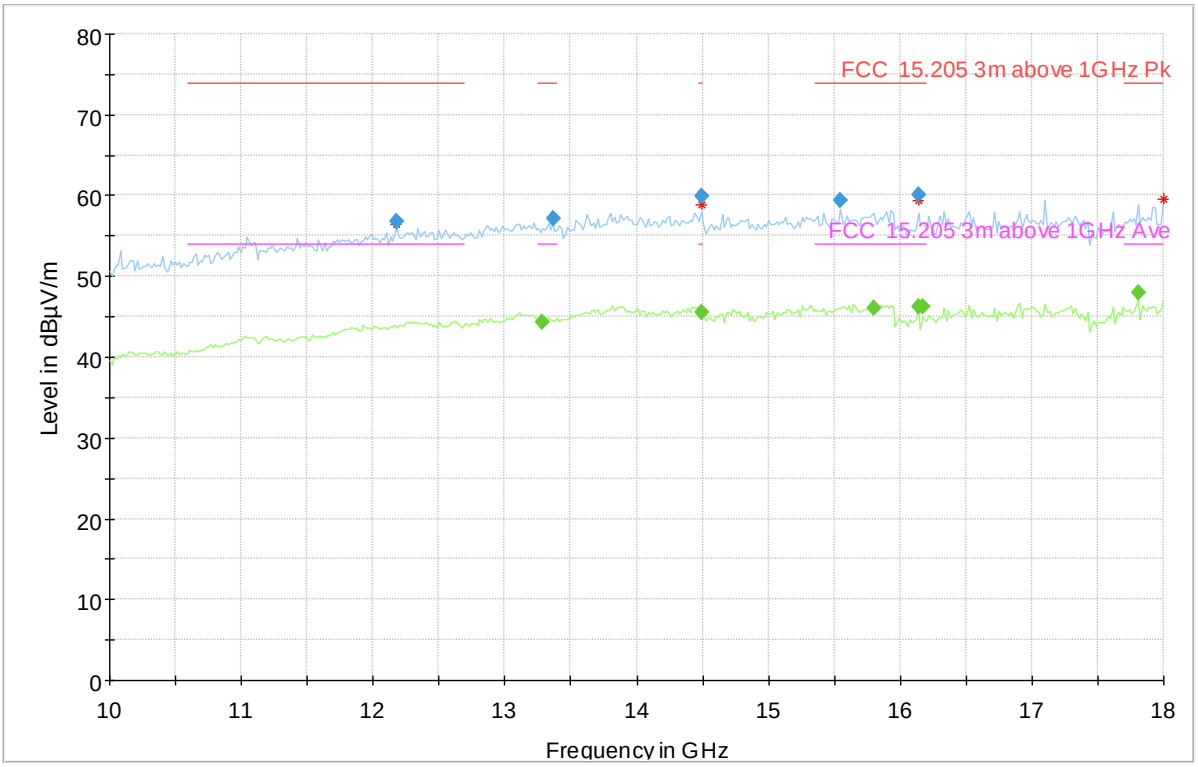
TEST ENGINEER: Richard Pennell

3.17.2 Profile; Orientation 1, flat, mid channel

Max hold trace with peak values (◆)

Peak measurements are shown in red (✳)

Max hold trace with average values (◆)



3.18 Radiated Emissions; 10 to 18 GHz (continued)

3.18.1 Data; Orientation 2, serial cable at bottom, Mid channel

Frequency	Peak	CISPR Average	Limit	Margin	Height	Pol	Azimuth	Corr.	
MHz	dBµV/	dBµV/m	dBµV/	dB	cm	H/V	Deg	dB/m	Status
No significant peaks found.									Pass

V = Vertical / H = Horizontal

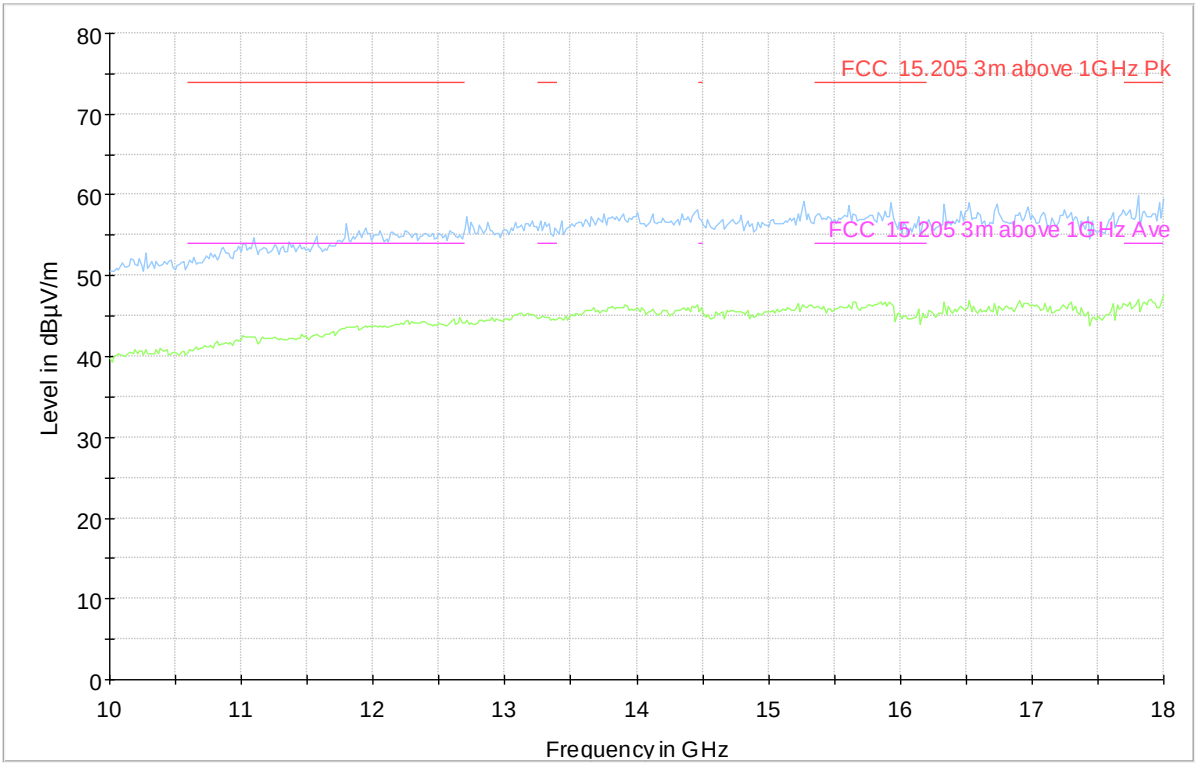
The measurements reported are the highest emissions relative to the FCC limits and take into account the antenna and cable loss factors. Measurements made according to the FCC test standard and Eurofins Hursley test procedure RHF-01.

TEST ENGINEER: Richard Pennell

3.18.2 Profile; Orientation 2, serial cable at bottom, Mid channel

Max hold trace with peak values (◆)

Max hold trace with average values (◆)



3.19 Radiated Emissions; 10 to 18 GHz (continued)

3.19.1 Data; Orientation 3, serial cable at side, Mid channel

Frequency	Peak	CISPR Average	Limit	Margin	Height	Pol	Azimuth	Corr.	
MHz	dBµV/	dBµV/m	dBµV/	dB	cm	H/V	Deg	dB/m	Status
No significant peaks found.									Pass

V = Vertical / H = Horizontal

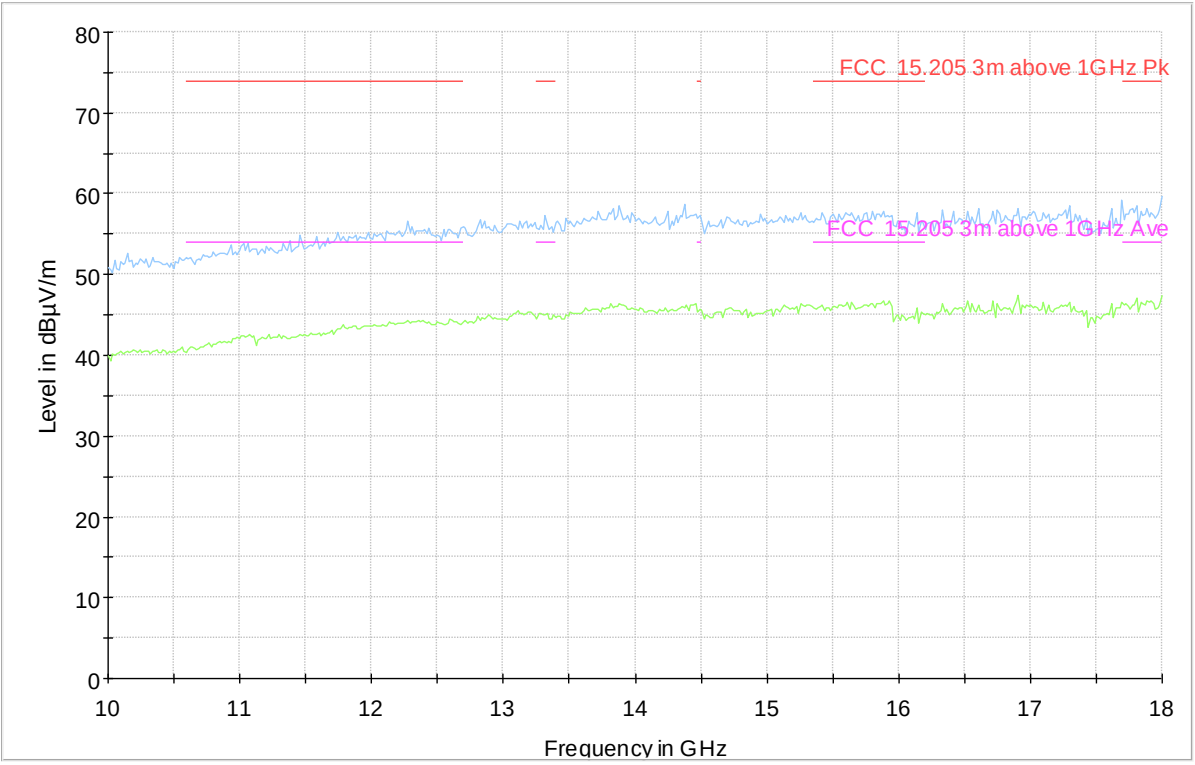
The measurements reported are the highest emissions relative to the FCC limits and take into account the antenna and cable loss factors. Measurements made according to the FCC test standard and Eurofins Hursley test procedure RHF-01.

TEST ENGINEER: Richard Pennell

3.19.2 Profile; Data; Orientation 3, serial cable at side, Mid channel

Max hold trace with peak values (◆)

Max hold trace with average values (◆)



3.20 Radiated Emissions; 10 to 18 GHz (continued)

3.20.1 Data; Orientation 1, flat, Bottom channel

Frequency	Peak	CISPR Average	Limit	Margin	Height	Pol	Azimuth	Corr.	
MHz	dBµV/	dBµV/m	dBµV/	dB	cm	H/V	Deg	dB/m	Status
No significant peaks found.									Pass

V = Vertical / H = Horizontal

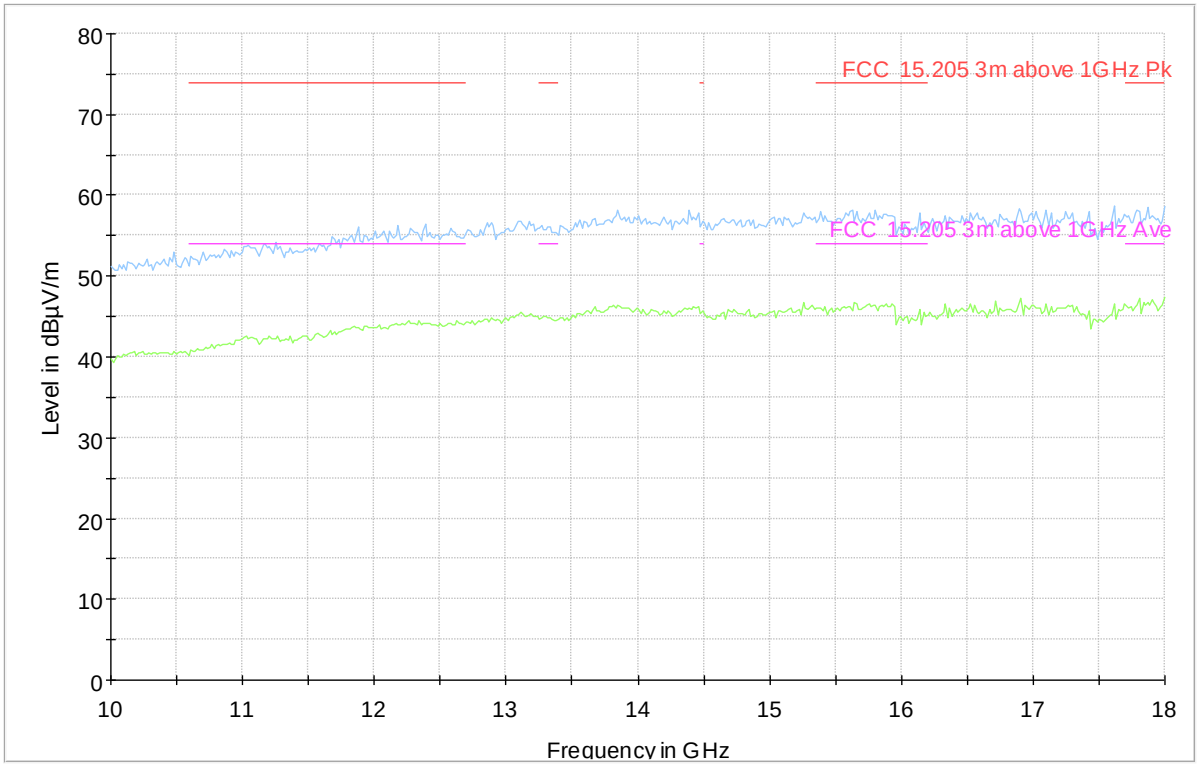
The measurements reported are the highest emissions relative to the FCC limits and take into account the antenna and cable loss factors. Measurements made according to the FCC test standard and Eurofins Hursley test procedure RHF-01.

TEST ENGINEER: Richard Pennell

3.20.2 Profile; Orientation 1, flat, Bottom channel

Max hold trace with peak values (◆)

Max hold trace with average values (◆)



3.21 Radiated Emissions; 10 to 18 GHz (continued)

3.21.1 Data; Orientation 1, flat, Top channel

Frequency	Peak	CISPR Average	Limit	Margin	Height	Pol	Azimuth	Corr.	
MHz	dBµV/	dBµV/m	dBµV/	dB	cm	H/V	Deg	dB/m	Status
No significant peaks found.									Pass

V = Vertical / H = Horizontal

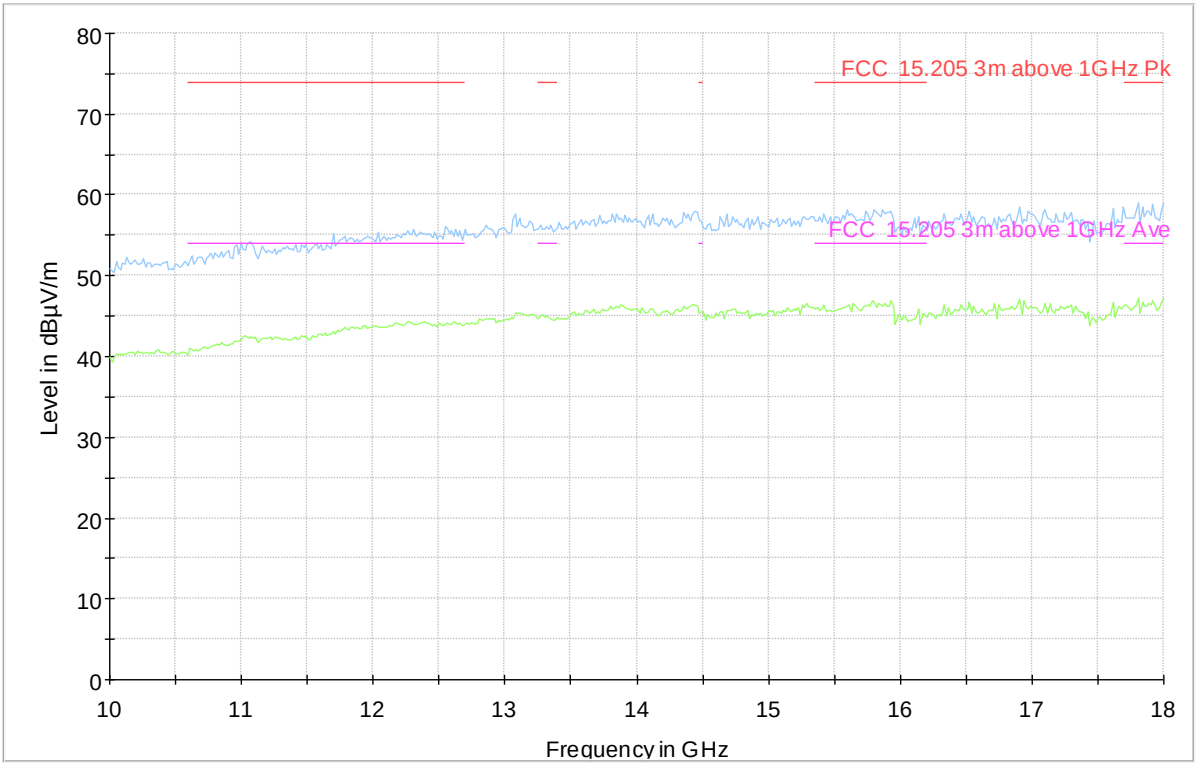
The measurements reported are the highest emissions relative to the FCC limits and take into account the antenna and cable loss factors. Measurements made according to the FCC test standard and Eurofins Hursley test procedure RHF-01.

TEST ENGINEER: Richard Pennell

3.21.2 Profile; Orientation 1, flat, Top channel

Max hold trace with peak values (◆)

Max hold trace with average values (◆)



3.22 Radiated Emissions; 18 to 25 GHz

Radiated emissions pre-scan profile measurements were taken at a distance of three metres on eight azimuths of the EUT in both horizontal and vertical antenna polarities in a semi-anechoic chamber for FCC measurements.

Using the pre-scan results as a guide, each emission from the EUT was maximised. Measurements were carried out a distance of three metres in a CISPR 16-1-4 compliant semi-anechoic chamber. Cable positions were then finally adjusted to produce the maximum emission levels. The EUT was tested in 3 axis and the worst-case results are recorded below.

3.22.1 Data; Orientation 1, flat, Top Channel

Frequency	Peak	CISPR Average	Limit	Margin	Height	Pol	Azimuth	Corr.	
MHz	dBµV/	dBµV/m	dBµV/	dB	cm	H/V	Deg	dB/m	Status
No significant peaks found									Pass

V = Vertical / H = Horizontal

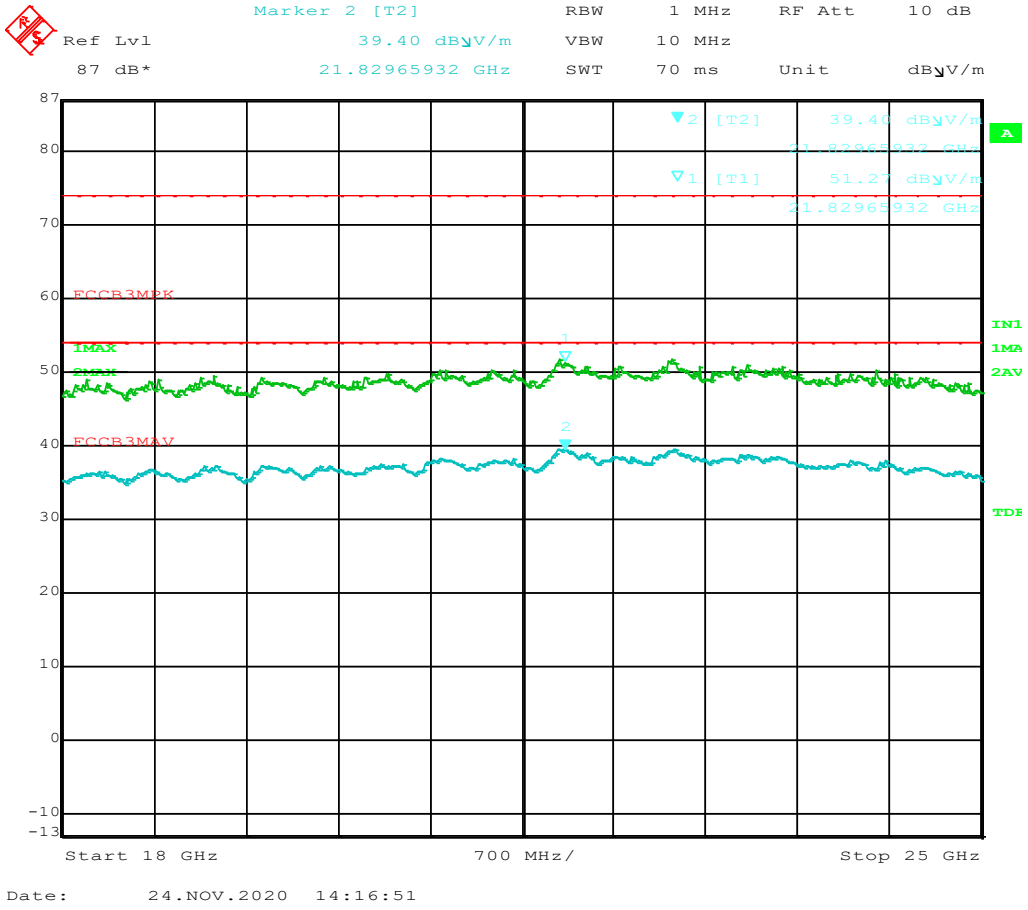
The measurements reported are the highest emissions relative to the FCC limits and take into account the antenna and cable loss factors. Measurements made according to the FCC test standard and Eurofins Hursley test procedure RHF-01.

TEST ENGINEER: Richard Pennell

3.22.2 Profile; Orientation 1, flat, Top Channel

Max hold trace with peak values (▽)

Max hold trace with average values (▼)



3.23 Radiated Emissions; 18 to 25 GHz (continued)

3.23.1 Data; Orientation 2, serial cable at bottom, Top Channel

Frequency	Peak	CISPR Average	Limit	Margin	Height	Pol	Azimuth	Corr.	
MHz	dBµV/	dBµV/m	dBµV/	dB	cm	H/V	Deg	dB/m	Status
No significant peaks found									Pass

V = Vertical / H = Horizontal

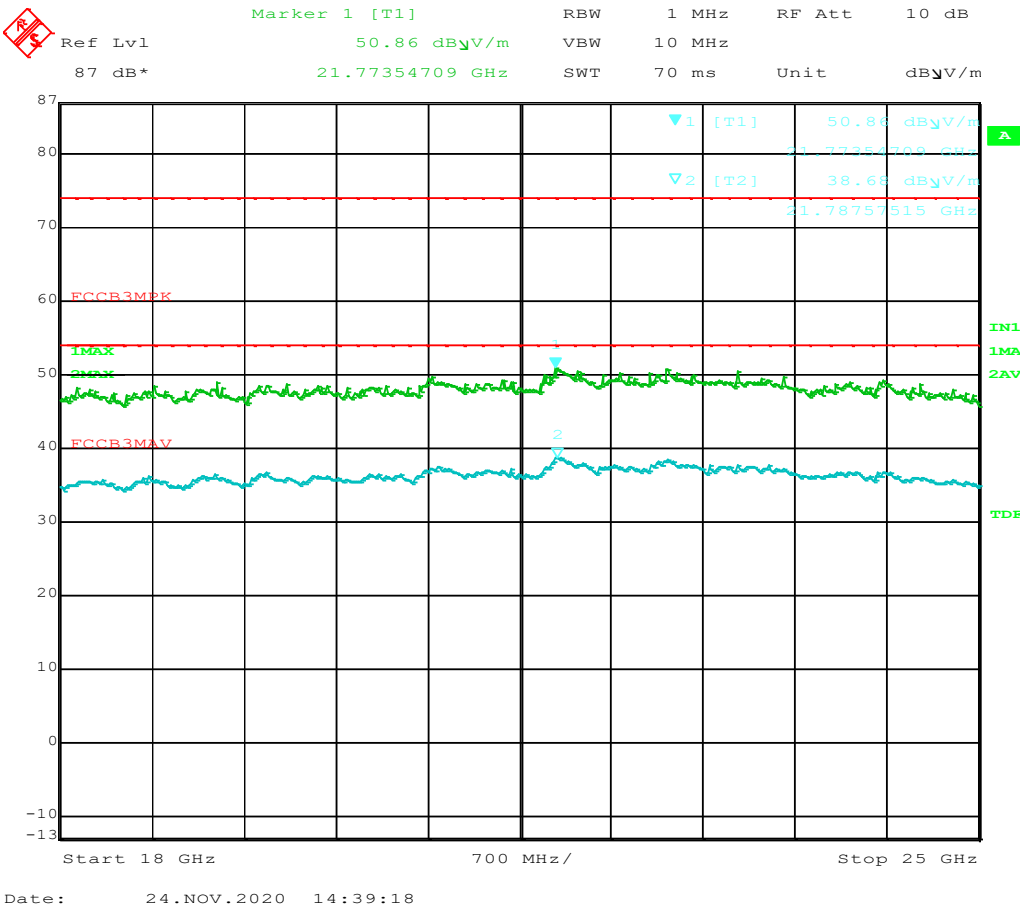
The measurements reported are the highest emissions relative to the FCC limits and take into account the antenna and cable loss factors. Measurements made according to the FCC test standard and Eurofins Hursley test procedure RHF-01.

TEST ENGINEER: Richard Pennell

3.23.2 Profile; Orientation 2, serial cable at bottom, Top Channel

Max hold trace with peak values (▽)

Max hold trace with average values (▼)



3.24 Radiated Emissions; 18 to 25 GHz (continued)

3.24.1 Data; Orientation 3, serial cable at side, Top Channel

Frequency	Peak	CISPR Average	Limit	Margin	Height	Pol	Azimuth	Corr.	
MHz	dBµV/	dBµV/m	dBµV/	dB	cm	H/V	Deg	dB/m	Status
No significant peaks found									Pass

V = Vertical / H = Horizontal

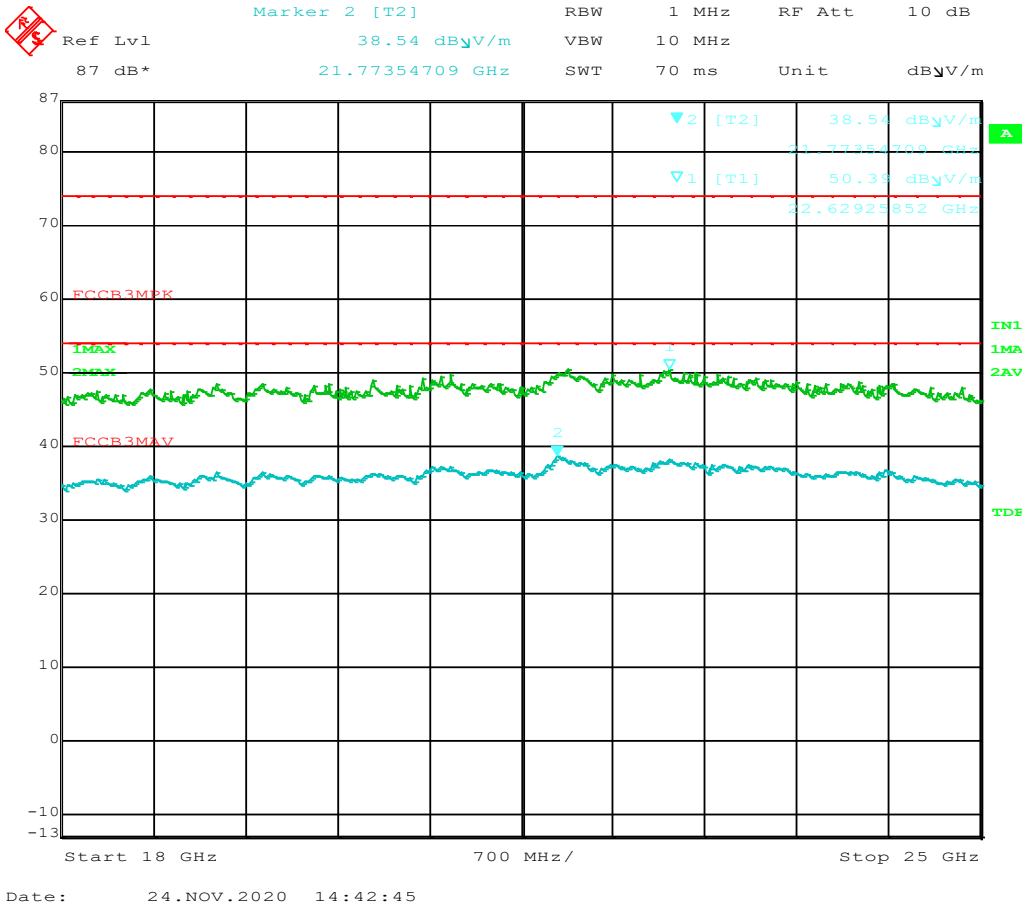
The measurements reported are the highest emissions relative to the FCC limits and take into account the antenna and cable loss factors. Measurements made according to the FCC test standard and Eurofins Hursley test procedure RHF-01.

TEST ENGINEER: Richard Pennell

3.24.2 Profile; Orientation 3, serial cable at side, Top Channel

Max hold trace with peak values (▽)

Max hold trace with average values (▼)



3.25 Radiated Emissions; 18 to 25 GHz (continued)

3.25.1 Data; Orientation 1, flat, Bottom Channel

Frequency	Peak	CISPR Average	Limit	Margin	Height	Pol	Azimuth	Corr.	
MHz	dBµV/	dBµV/m	dBµV/	dB	cm	H/V	Deg	dB/m	Status
No significant peaks found									Pass

V = Vertical / H = Horizontal

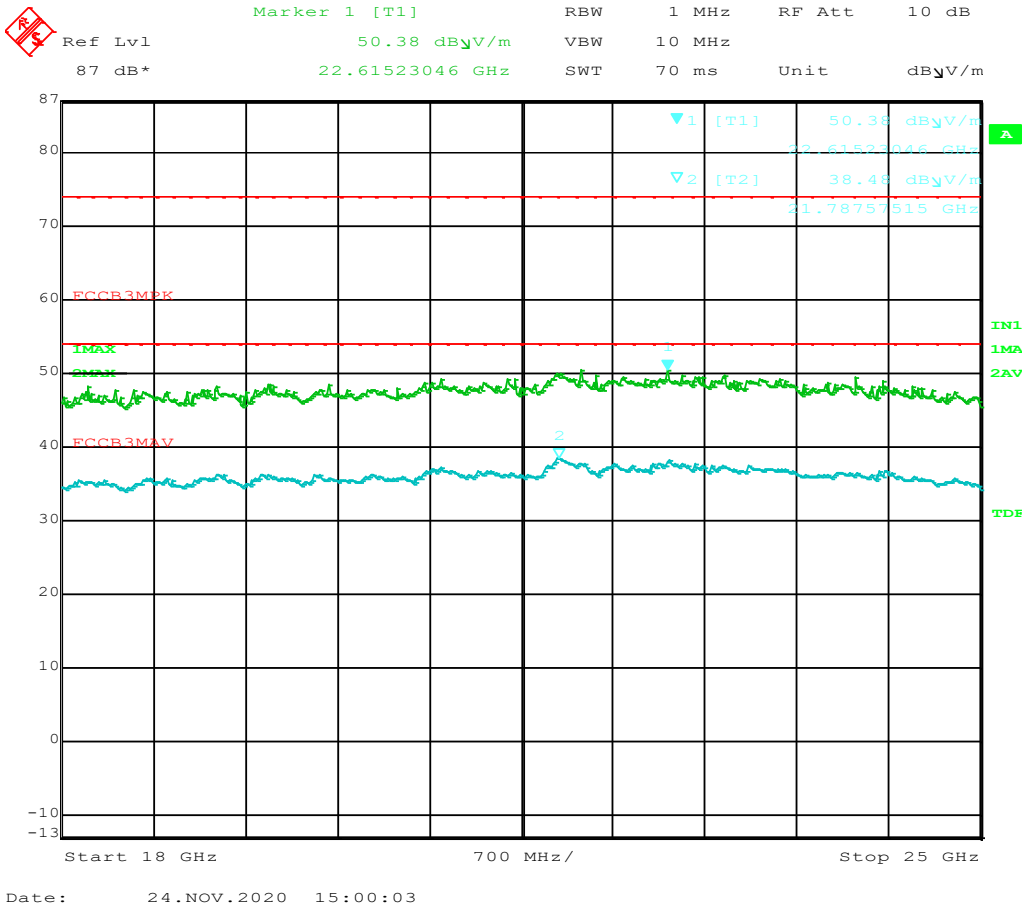
The measurements reported are the highest emissions relative to the FCC limits and take into account the antenna and cable loss factors. Measurements made according to the FCC test standard and Eurofins Hursley test procedure RHF-01.

TEST ENGINEER: Richard Pennell

3.25.2 Profile; Orientation 1, flat, Bottom Channel

Max hold trace with peak values (▽)

Max hold trace with average values (▼)



3.26 Radiated Emissions; 18 to 25 GHz (continued)

3.26.1 Data; Orientation 1, flat, Mid Channel

Frequency	Peak	CISPR Average	Limit	Margin	Height	Pol	Azimuth	Corr.	
MHz	dBµV/	dBµV/m	dBµV/	dB	cm	H/V	Deg	dB/m	Status
No significant peaks found									Pass

V = Vertical / H = Horizontal

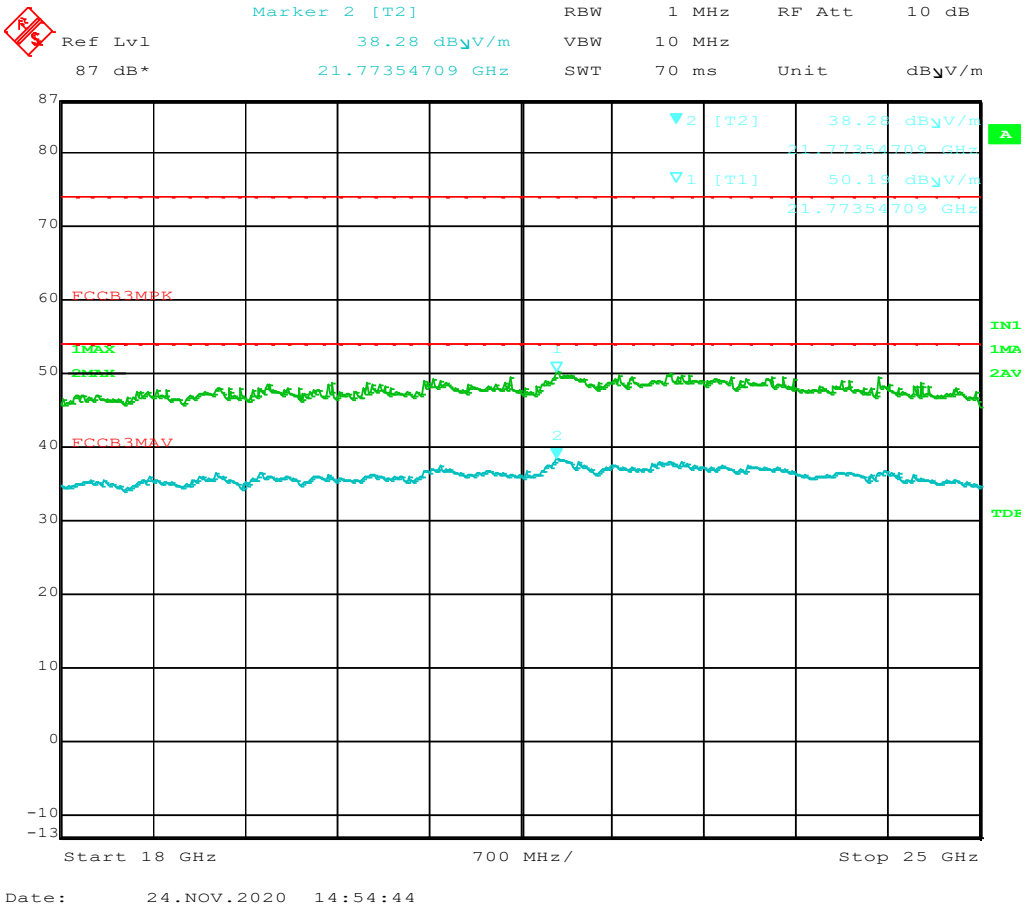
The measurements reported are the highest emissions relative to the FCC limits and take into account the antenna and cable loss factors. Measurements made according to the FCC test standard and Eurofins Hursley test procedure RHF-01.

TEST ENGINEER: Richard Pennell

3.26.2 Profile; Orientation 1, flat, Mid Channel

Max hold trace with peak values (▽)

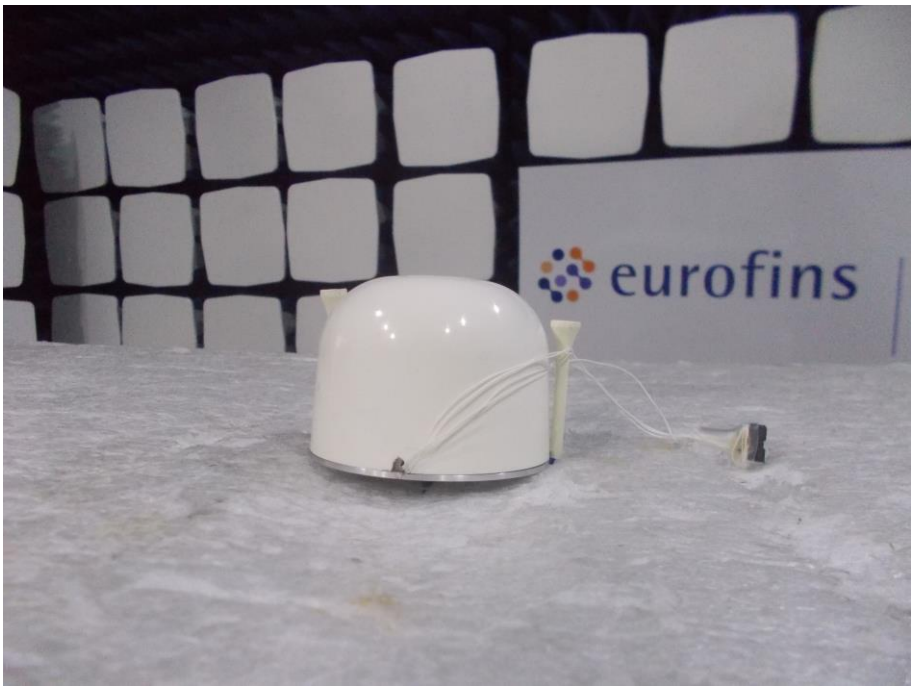
Max hold trace with average values (▼)



4.0 PHOTO LOG

Emissions:

Radiated emissions
Orientation 1 flat



Radiated emissions
Orientation 2 serial cable side

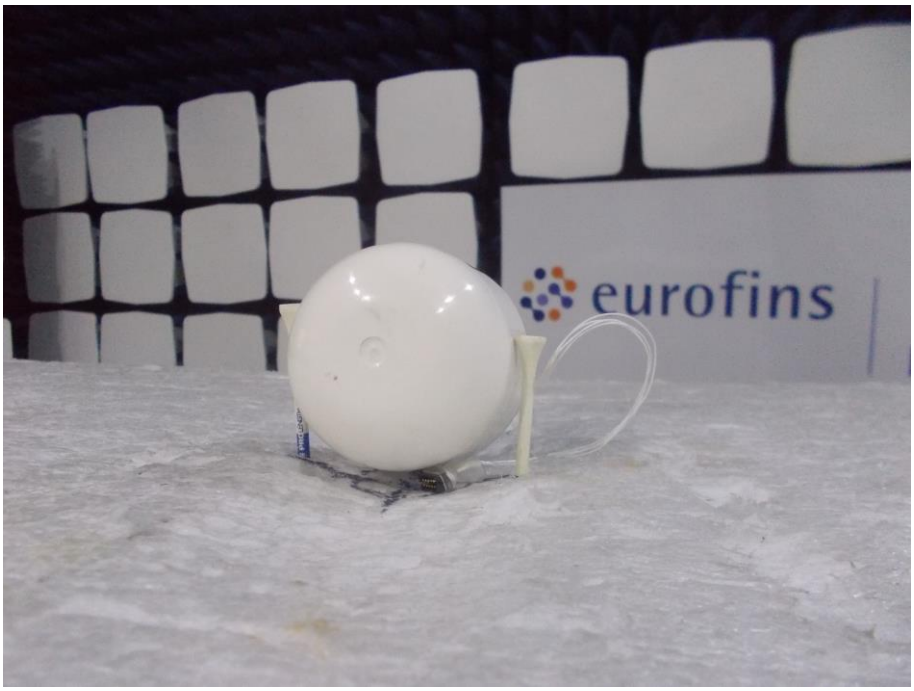
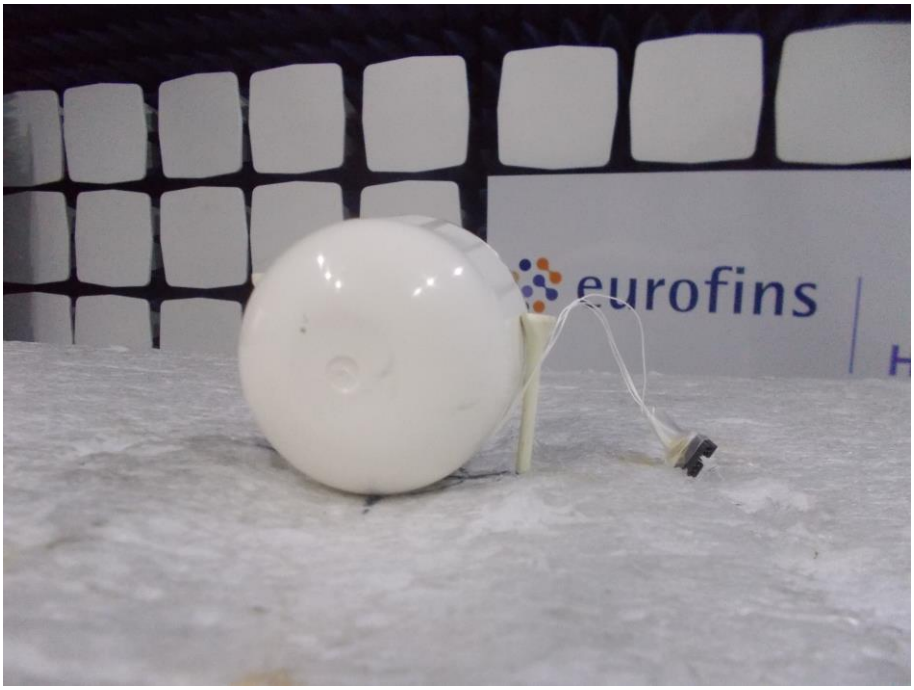


Photo Log (continued)

Emissions:

Radiated emissions
Orientation 3 serial cable bottom



5.0 MEASUREMENT UNCERTAINTIES

Emissions tests

For all emissions tests, measurement uncertainties have been calculated in line with the requirements of CISPR 16-4-2 to give a confidence level of greater than 95%. In all cases the laboratories calculated uncertainty values (known as Ulab) are equal to or are less than the expected uncertainty values contained in CISPR 16-4-2 (known as Ucispr). Below is a list of the laboratories calculated measurement uncertainties:

Conducted emissions:

Via AMN/LISN:	±3.27 dB (9 kHz – 150 kHz), ±3.28 dB (150 kHz – 30 MHz)
Via AAN/ISN:	±4.99 dB (150 kHz – 30 MHz)
Via CVP:	±3.47 dB (150 kHz – 30 MHz)
Via CP:	±2.69 dB (150 kHz – 30 MHz)
Via 100 Ω:	±2.69 dB (150 kHz – 30 MHz)
Clicks:	±3.34 dB (150 kHz – 30 MHz)
Harmonics:	±5.82 % (100 Hz – 2 kHz)
Flicker:	±3.78 % (worst case for all parameters)

Radiated emissions:

H-Field:	±2.73 dB (9 kHz – 3 MHz), ±2.88 dB (3 MHz – 30 MHz)
D = 3.0 m (Horizontal):	±3.92 dB (30 MHz – 200 MHz), ±3.78 dB (200 MHz – 1 GHz)
D = 3.0 m (Vertical):	±3.74 dB (30 MHz – 200 MHz), ±5.06 dB (200 MHz – 1 GHz)
D = 3.0 m:	±4.50 dB (1 GHz – 6 GHz), ±4.04 dB (6 GHz – 18 GHz), ±4.27 dB (18 GHz – 40 GHz)
D = 10.0 m (Horizontal):	±4.53 dB (30 MHz – 200 MHz), ±4.61 dB (200 MHz – 1 GHz)
D = 10.0 m (Vertical):	±4.41 dB (30 MHz – 200 MHz), ±4.77 dB (200 MHz – 1 GHz)

6.0 ANNEX – CONDUCTED EMISSIONS RESULTS

6.1 DTS Bandwidth

6.1.1 Measurement method

Test was conducted in accordance with ANSI C63.10 Clause 11.8 Option 1:

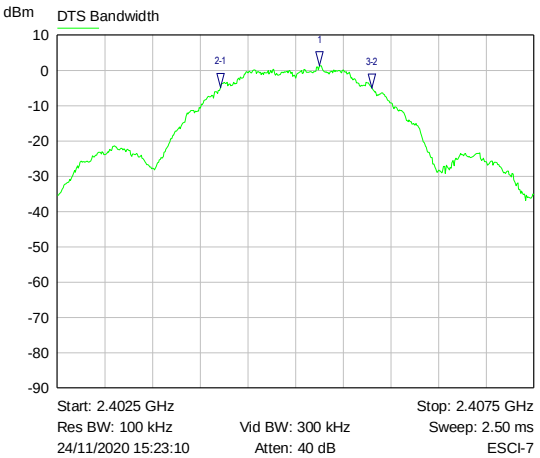
a) Set resolution bandwidth to 100 kHz
b) Set the video bandwidth to ≥ 3 x RBW
c) Detector = Peak.
d) Trace mode = max hold.
e) Sweep = auto couple.
f) Allow the trace to stabilize.
g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

6.1.2 Test results

Channel	6dB DTS Bandwidth (MHz)	Requirement	Result
Bottom	1.59	> 500 kHz	Pass
Middle	1.47	> 500 kHz	Pass
Top	1.59	> 500 kHz	Pass

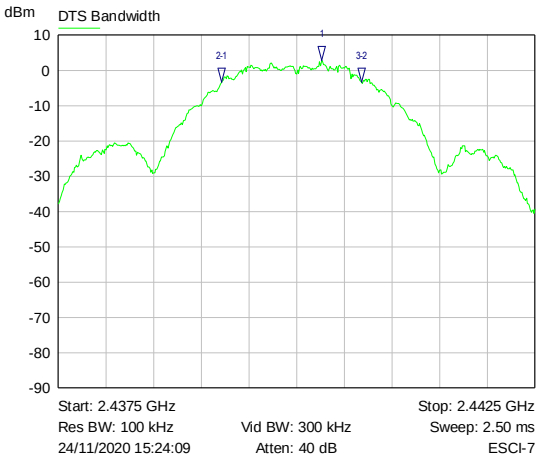
Table 1: DTS Bandwidth

6.1.3 Profile; DTS Bandwidth



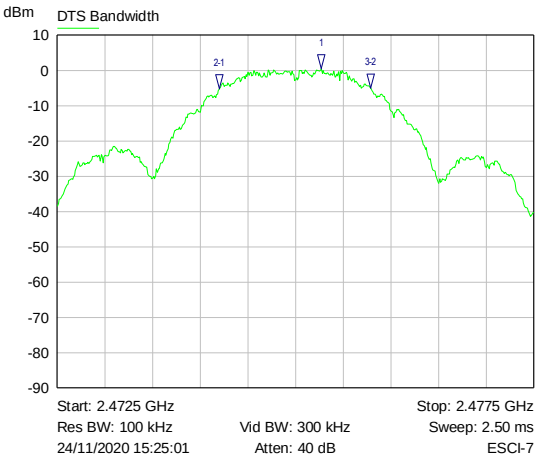
Mkr	Trace	X-Axis	Value	Notes
1	DTS Bandwidth	2.4053 GHz	1.35 dBm	
2-1	DTS Bandwidth	-1.0400 MHz	-6.24 dB	Relative to max
3-2	DTS Bandwidth	1.5900 MHz	-0.12 dB	Relative to marker 2

Bottom



Mkr	Trace	X-Axis	Value	Notes
1	DTS Bandwidth	2.4403 GHz	2.76 dBm	
2-1	DTS Bandwidth	-1.0500 MHz	-6.02 dB	Relative to max
3-2	DTS Bandwidth	1.4700 MHz	-0.08 dB	Relative to marker 2

Middle



Mkr	Trace	X-Axis	Value	Notes
1	DTS Bandwidth	2.4753 GHz	0.53 dBm	
2-1	DTS Bandwidth	-1.0700 MHz	-5.78 dB	Relative to max
3-2	DTS Bandwidth	1.5900 MHz	0.19 dB	Relative to marker 2

Top

Figure 1: DTS Bandwidth plots

6.2 Maximum Peak Conducted Output Power

6.2.1 Measurement method

As the analyser could be set RBW ≥ DTS bandwidth, the test was conducted in accordance with ANSI C63.10 Clause 11.9.1.1:

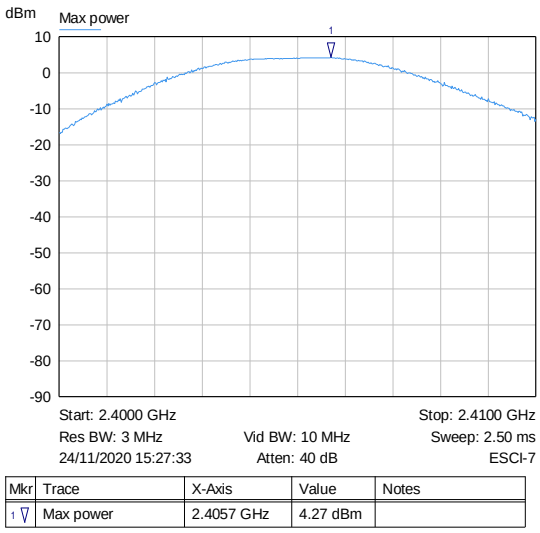
a) Set the RBW ≥ DTS bandwidth.
b) Set VBW ≥ 3 x RBW.
c) Set span ≥ 3 x RBW
d) Sweep time = auto couple.
e) Detector = peak.
f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use peak marker function to determine the peak amplitude level.

6.2.2 Test results

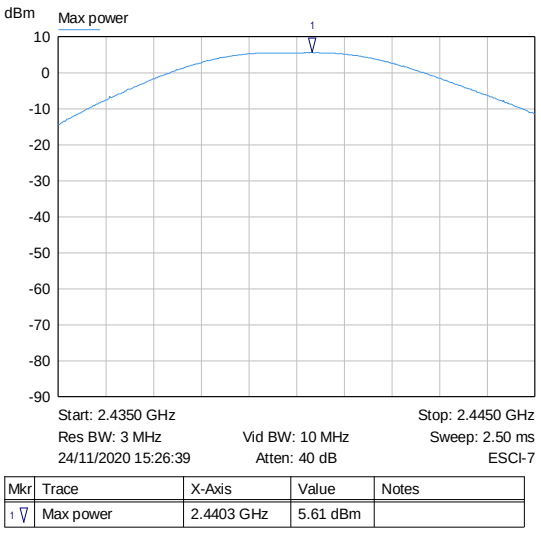
Channel	Channel Power (dBm)	Limit (dBm)	Result
Bottom	4.27	30.0	Pass
Middle	5.61	30.0	Pass
Top	4.18	30.0	Pass

Table 2: Channel Power

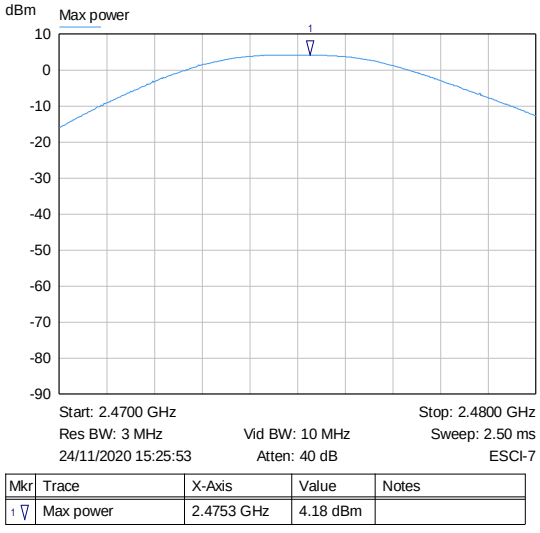
6.2.3 Profile; Maximum Peak Conducted Output Power



Bottom



Middle



Top

Figure 2: Peak Conducted Power plots

6.3 Maximum Power Spectral Density

6.3.1 Measurement method

As conducted power was measured as Maximum Peak Conducted Power, measurement was performed in accordance with ANSI C63.10 Clause 11.10.2:

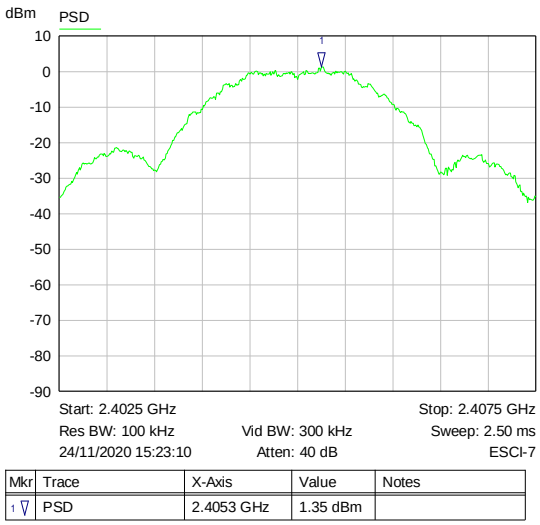
a) Set analyzer center frequency to DTS channel center frequency.
b) Set the span to 1.5 x DTS bandwidth.
c) Set the RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
d) Set the VBW ≥ 3 x RBW.
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum amplitude level within the RBW.
j) If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

6.3.2 Test results

Channel	Peak Marker reading (dBm)	Limit (dBm/3kHz)	Result
Bottom	1.35	8.0	Pass
Middle	2.76	8.0	Pass
Top	0.53	8.0	Pass

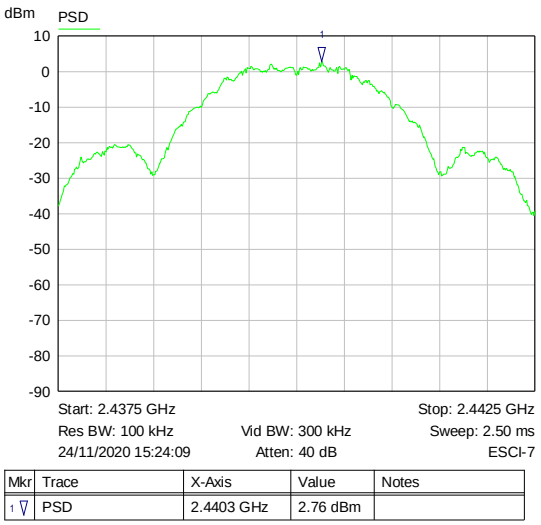
Table 3: Spectral Density results

6.3.3 Profile; Maximum Power Spectral Density



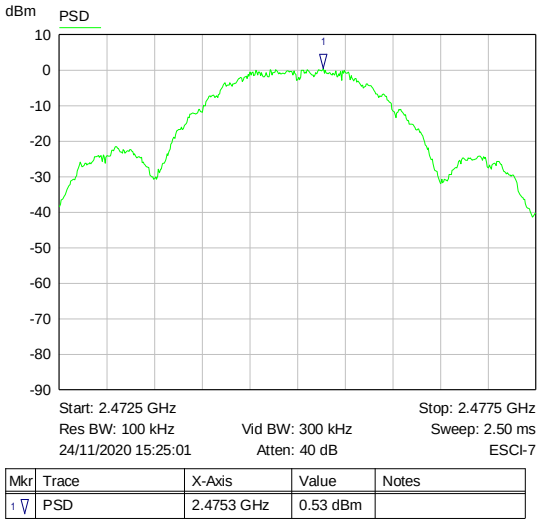
Mkr	Trace	X-Axis	Value	Notes
1	PSD	2.4053 GHz	1.35 dBm	

Bottom



Mkr	Trace	X-Axis	Value	Notes
1	PSD	2.4403 GHz	2.76 dBm	

Middle



Mkr	Trace	X-Axis	Value	Notes
1	PSD	2.4753 GHz	0.53 dBm	

Top

Figure 3: Spectral Density plots

6.4 Emissions in non-restricted frequency bands

6.4.1 Measurement method

Since peak power measurements were made using a peak detector, the same detector will be used for unwanted emissions. The unwanted emissions shall be at least 20dB lower than the wanted emission.

First, establish a reference level in accordance with ANSI C63.10 Clause 11.11.2:

a) Set instrument center frequency to DTS channel center frequency.
b) Set the span to ≥ 1.5 x DTS bandwidth.
c) Set the RBW = 100 kHz.
d) Set the VBW ≥ 3 x RBW.
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum PSD level.

Then measure the emission levels in accordance with ANSI C63.10 Clause 11.11.3

j) Set the center frequency and span to encompass frequency range to be measured.
k) Set the RBW = 100 kHz.
l) Set the VBW ≥ 3 x RBW.
m) Detector = peak.
n) Sweep time = auto couple.
o) Trace mode = max hold.
p) Allow trace to fully stabilize.
q) Use the peak marker function to determine the maximum amplitude level.

6.4.2 Test results

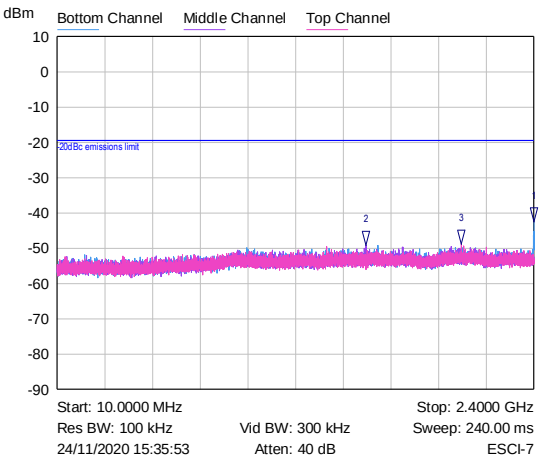
The reference trace was taken from the Power Spectral Density Measurement which used the same settings.

For ease of measurement, maximum values are reported anywhere in the frequency band of investigation, whether or not it is outside a restricted band. Further measurements in restricted bands are in the next section.

Channel	Maximum Peak level in 100 kHz RBW (dBm)	-20 dBc (dBm)	Maximum emission (dBm)	Result
Bottom	1.35	-18.65	-42.44	Pass
Middle	2.76	-17.24	-47.00	Pass
Top	0.53	**-19.47**	-46.00	Pass

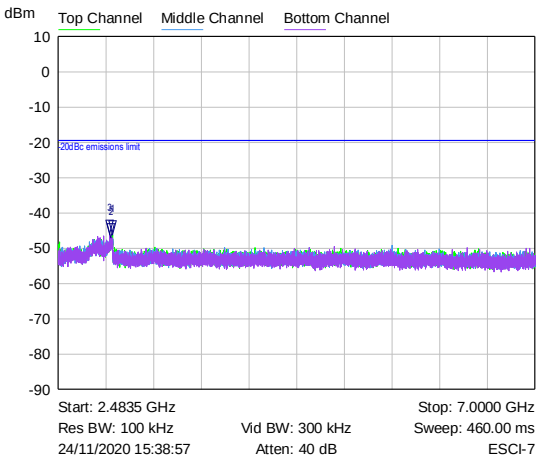
Table 4: Emissions in non-restricted bands

6.4.3 Profile; Emissions in non-restricted frequency bands



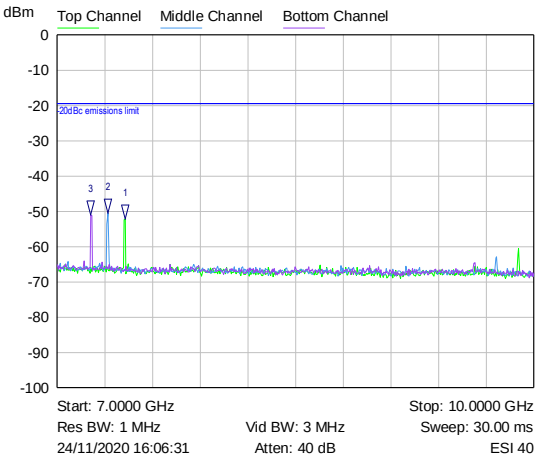
Mkr	Trace	X-Axis	Value	Notes
1	Bottom Channel	2.4000 GHz	-42.44 dBm	
2	Middle Channel	1.5569 GHz	-49.20 dBm	
3	Top Channel	2.0361 GHz	-48.85 dBm	

20 – 2400 MHz



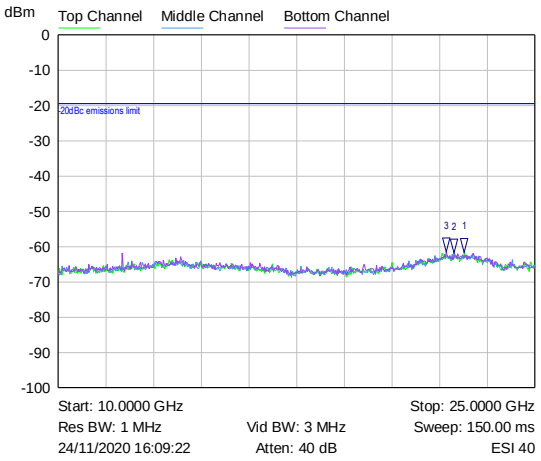
Mkr	Trace	X-Axis	Value	Notes
1	Top Channel	2.9956 GHz	-46.17 dBm	
2	Middle Channel	2.9781 GHz	-47.00 dBm	
3	Bottom Channel	2.9679 GHz	-46.00 dBm	

2483.5 – 7000 MHz



Mkr	Trace	X-Axis	Value	Notes
1	Top Channel	7.4269 GHz	-52.22 dBm	
2	Middle Channel	7.3186 GHz	-50.42 dBm	
3	Bottom Channel	7.2104 GHz	-51.00 dBm	

7 – 10 GHz (1 MHz RBW)



Mkr	Trace	X-Axis	Value	Notes
1	Top Channel	22.7756 GHz	-61.60 dBm	
2	Middle Channel	22.4449 GHz	-61.77 dBm	
3	Bottom Channel	22.2044 GHz	-61.48 dBm	

10 – 25 GHz (1 MHz RBW)

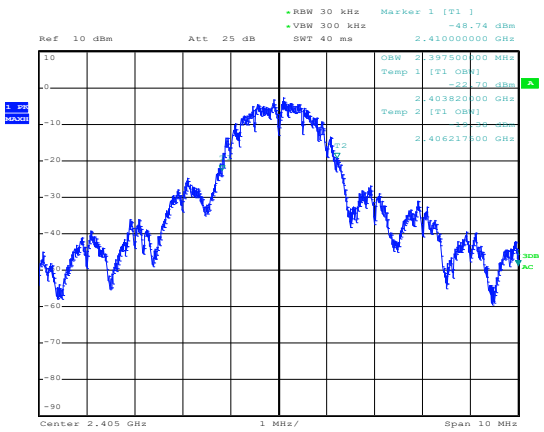
Figure 4: Emissions in non-restricted frequency bands

6.5 Occupied bandwidth

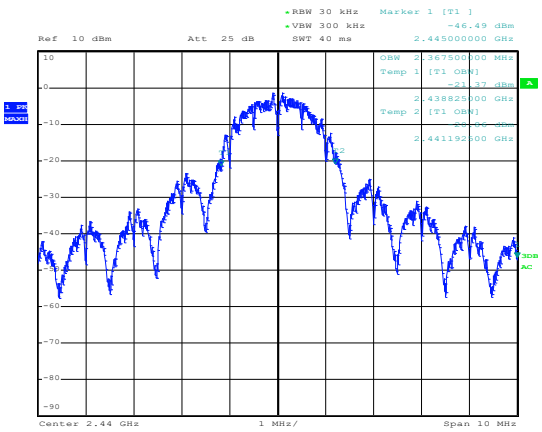
99% occupied bandwidth measured using the inbuilt function in the spectrum analyser

Channel	Occupied Bandwidth (MHz)	Requirement	Result
Bottom	2.3975	None	For information
Middle	2.3675	None	For information
Top	2.3800	None	For information

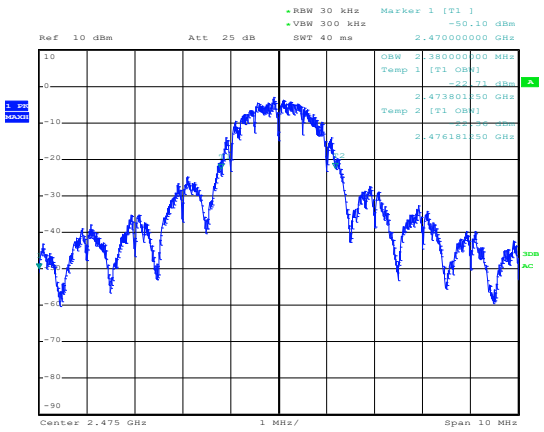
Table 5: Occupied Bandwidth



Bottom



Middle



Top

Figure 5: Occupied Bandwidth

6.6 Test equipment

Description	Manufacturer	Name	Serial Number	Calibration certificate Or Calibration due
Spectrum Analyser	Rohde & Schwarz	ESCI 7	HEMC #552	01/07/2021
Spectrum Analyser	Rohde & Schwarz	ESIB 40	HEMC #021	12/08/2021

Table 6: Test Equipment

End of Document